Wireless World

RADIO AND ELECTRONICS

NOV. 1947

1/6

Vol. LIII. No. 11

REVIEW OF TECHNICAL PROGRESS

B.I. Callender's

SERVICE TO INDUSTRY

B. I. Callender's have branch offices in each of the principal cities of Great Britain Staffed by specialists they are fully equipped to meet the needs of the electrical industry.

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A Superb Instrument for the Perfect Reproduction of Gramophone Records

Here at last is an instrument which will give you the perfect record reproduction of which you have dreamed . . . the full beauty of the quiet passages . . . the excitement of the finale . . . the vigour of the bass . . . the trill of the soprano. And the Collaro Microgram is completely self contained . . . completely portable. Just plug in . . . and hear your records as they were *meant* to be heard. Ask to hear the Microgram at your usual dealer's . . . or write to address below for Illustrated Brochure.

The " De Luxe " Model illustrated is complete with 6½ inch Speaker, and lightweight Crystal Pick-up, neatly fitted into a handsome imitation lizard-skin case.

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Portable Electric Gramophone

PRICES :

De Luxe Model £19 19
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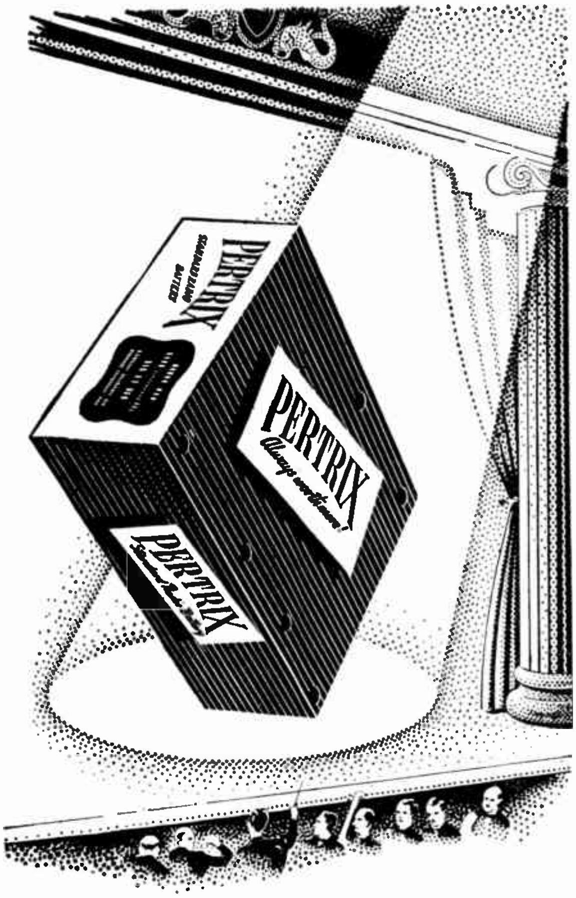

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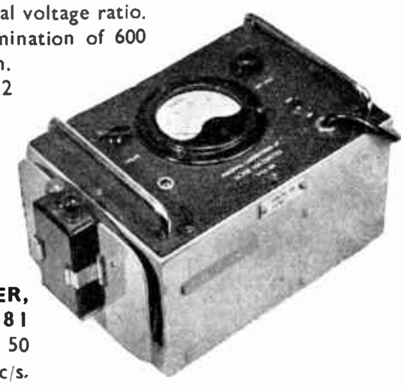
PERTRIX RADIO BATTERIES, in the red and yellow pack, are now firmly established in the post-war market. One reason—a Pertrix battery supplies power and nothing else. No mush or crackle to interfere with good listening — the result of a battery doing its work quietly, efficiently and unobtrusively. What's more it goes on doing it for a long time. Stick to Pertrix.

HOLSUN BATTERIES LTD

137 Victoria Street, London, S.W.1.

P9

★ **A.F. ATTENUATOR, TYPE 1358**
Frequency Range, zero to 20Kc/s. Input Impedance, 600 ohms. Attenuation, 0-110 dB in steps of 1 dB, ± 1% nominal voltage ratio. Internal Termination of 600 ohms at option. Dissipation, 2 watts.



★ **DIODE VOLTMETER, TYPE 281**
0.1-150 volts, 50 c/s. to 250 Mc/s. ± 2% of F.S.D. Stable zero setting. Alternative model having additional d.c. voltage ranges available.

★ **HIGH DISSIPATION RESISTANCE BOX, TYPE 1752**
0-1 meg. in 5 decades. 6 watts per resistor, 60 watts per decade, except last decade which is 20 watts. Accuracy ± 5%. Voltage limit 1,000 volts.

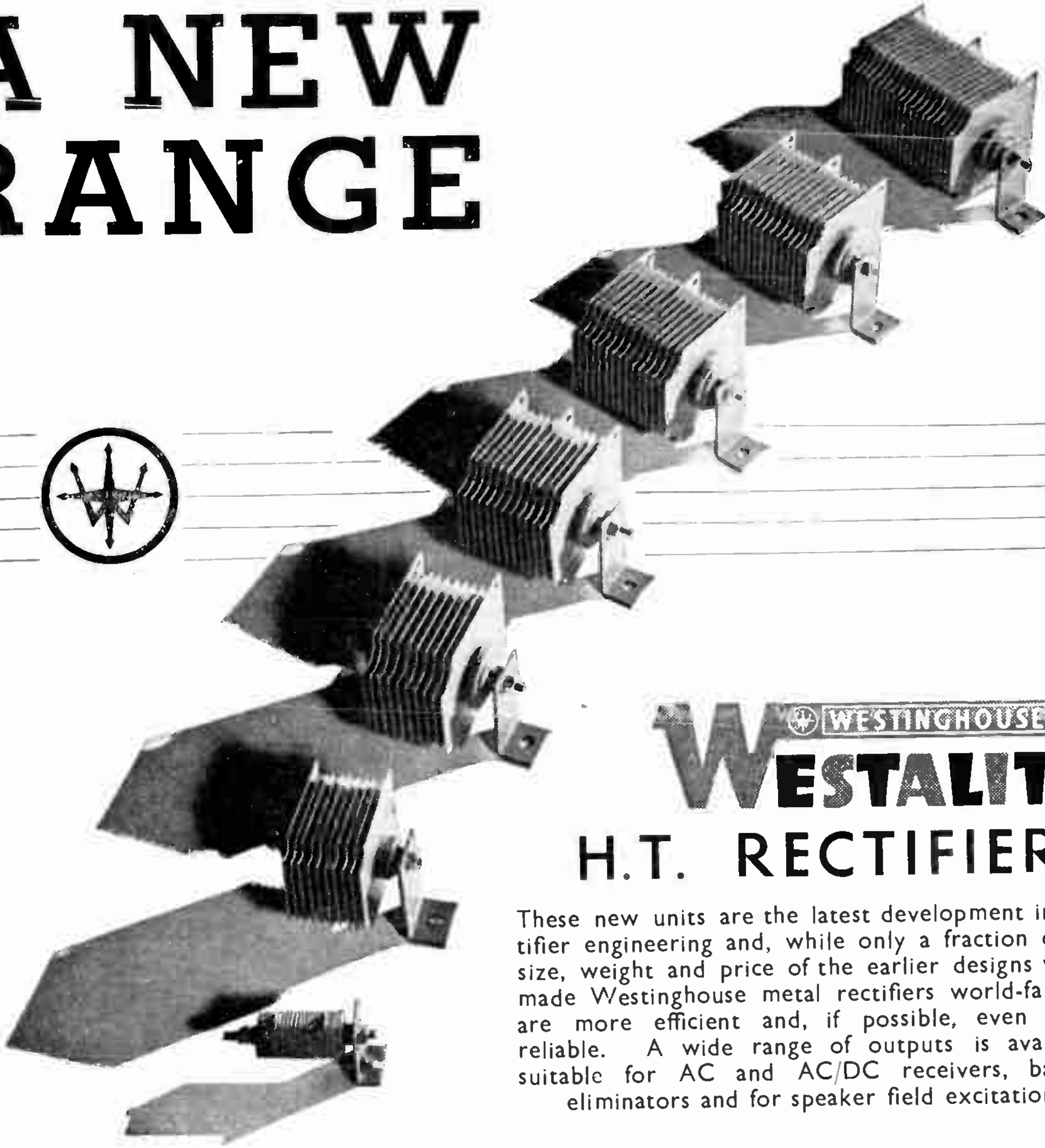
PRICES ON APPLICATION

Furzehill **LABORATORIES LTD.**

BOREHAM WOOD, HERTS

TELEPHONE: ELSTREE 1137

A NEW RANGE



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WESTALITE

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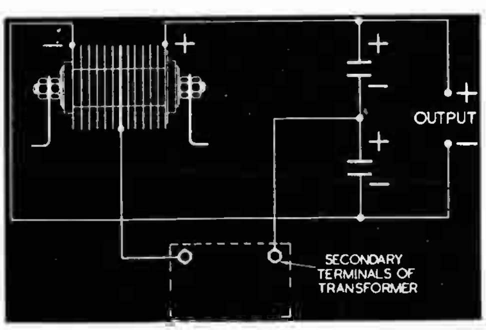
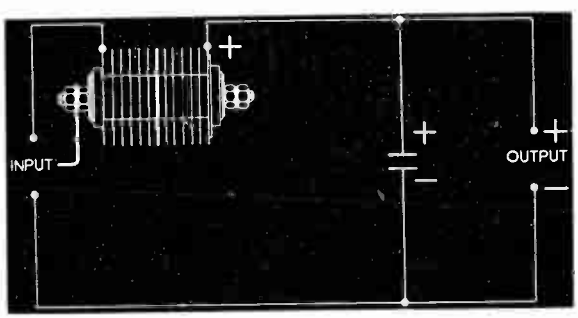
These new units are the latest development in rectifier engineering and, while only a fraction of the size, weight and price of the earlier designs which made Westinghouse metal rectifiers world-famous, are more efficient and, if possible, even more reliable. A wide range of outputs is available, suitable for AC and AC/DC receivers, battery eliminators and for speaker field excitation.



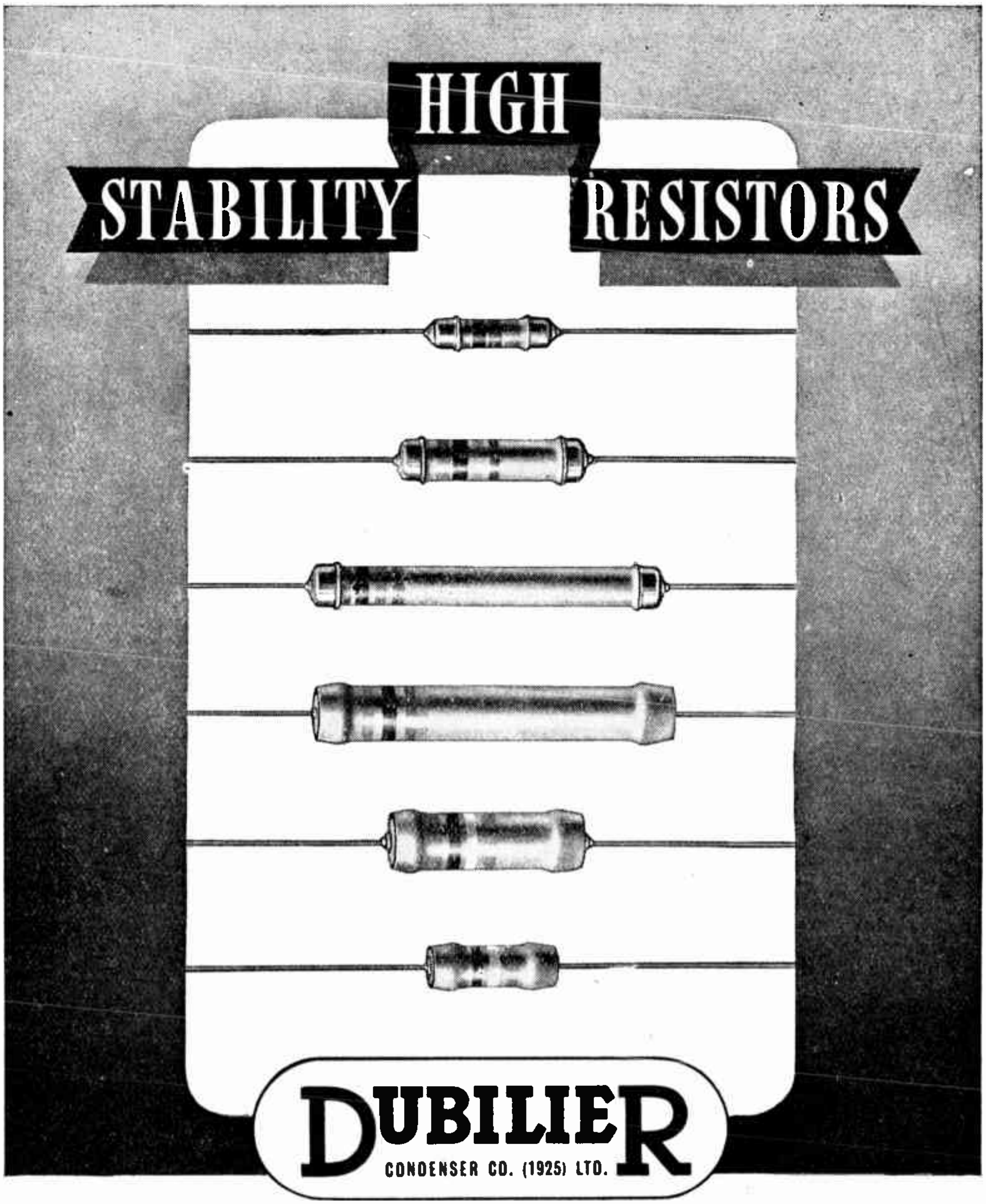
Voltage-doubler circuit



Half-wave circuit

Details are given in leaflet MR. 14 Suppt. 1, a copy of which will be sent on request to Dept. W.W.

WESTINGHOUSE BRAKE & SIGNAL CO., LTD., 82, York Way, King's Cross, London, N.1



WHERE HIGH STABILITY IS ESSENTIAL

For operation in certain special conditions, a high degree of stability is the chief characteristic required of fixed resistors. For example, in television, electronic and instrument applications where maintenance of maximum stability is desired over long periods of continuous use, high stability in resistors must be the primary qualification. The particular process of manufacture to which Dubilier High Stability Resistors are subjected ensures this great stability of resistance value, coupled with a low temperature coefficient of resistance, a negligible voltage-coefficient and a low "noise level".

In all conditions where high stability is vital, a selection from this specially designed range of Dubilier High Stability Resistors type R should be made. Full technical details and prices will be sent upon receipt of your enquiry.

DUBILIER CONDENSER CO. (1925) LTD., DUCON WORKS, VICTORIA ROAD, NORTH ACTON, W.3
'Phone: Acorn 2241. 'Grams: Hivoltcon, Phone, London. Cables: Hivoltcon, London. Marconi International Code.

D11

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ALL-IN-ONE RADIOMETER

tests everything electrical, Radio and P.A. Equipments, Household appliances of all kinds, Car Lighting Systems, Bell and Teleprinter Circuits. May be used on AC or DC mains.

25/-

Still in short supply but ask your Local Dealer to put your name down on his waiting list.

The SHERLOCK HOLMES OF RADIO SINCE 1930

Stabilised Insulation
BY MODERN IMPREGNATION METHODS

HYMEG

HIGH-SPEED PRODUCTION

HYMEG Synthetic Insulating Varnishes are recognised and widely used for their mechanical rigidity, improvement of electrical properties of windings; heat, moisture, oil, acid and alkali resistance as well as for the considerably reduced stoving time necessary.

Now, special methods of continuous conveyor impregnation and baking developed with the use of HYMEG have still further reduced processing times to a fraction of those previously believed necessary.

Often faster than infra-red baking with none of the defects, reduced handling, absence of special jigs, with complete freedom from blistering, bubbling and porosity, are some of the advantages claimed and substantiated for HYMEG High Speed Production methods.

HYMEGLAS

GLASS FIBRE INSULATION SYSTEM

After much research in our laboratories and in conjunction with many well-known specialist manufacturers, we have now evolved the Hymeglas system of Insulation which comprises modifications of Hymeg as used for coil impregnation to meet the varying conditions applying to each field of manufacture.

This integrated system of development is successful in enabling machines to be designed and operated without weak links in the chain of insulation below 200°C. Thus the fullest advantage is taken of modern glass fibre insulation by providing a degree of bonding and insulation at every point in which the uniting of Hymeg impregnation with the Hymeg as used for subsidiary insulations gives a solid homogeneous winding of equally efficient characteristics and heat resistance throughout.

Hymeglas therefore virtually eliminates any risk of insulation failure and enables motors and the like to operate under abnormal conditions for long periods without risk of electrical breakdown.

Due to the excellent space factor of glass fibre as compared with the more usual asbestos and mica Class B insulations, it is often possible in redesigning with the Hymeglas system to employ larger copper sections with well-known advantages.

The Berger Technical Service—the research work of which produced "HYMEG" and "HYMEGLAS" is available to advise manufacturers on all problems of insulation. Get in touch now with—

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MANUFACTURERS OF HIGH-PERFORMANCE INSULATING VARNISHES AND ENAMELS

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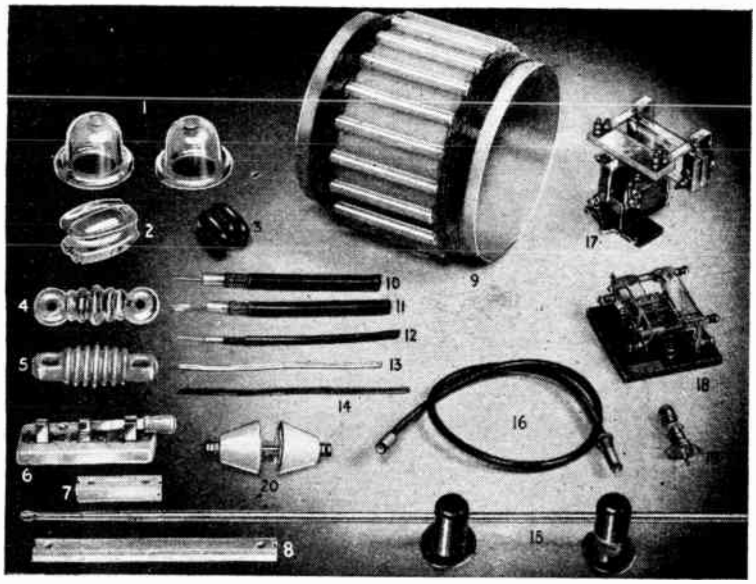

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2. **Pyrex** " Egg " Aerial Insulators ... ... " 1/3
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4. **Pyrex** " Aerial " Insulators ... ... " 1/-
5. **Eddystone** No. 999 Aerial Insulators ... " 2/6
6. S.P.D.T. Knife Switch ... ... " 1/6
7. 2in. Ceramic Spreaders ... ... " 0/8
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13. **Telcon** 150 ohm Twin Line ... ... per yd. 0/6 (Also available in 300 ohm, same price.)
14. **Belling-Lee** Twin 80 ohm " Television " Cable ... ... " 0/7½
15. **Webb's** Car Aerial, available for either buffer or scuttle fixing ... ... each 23/6
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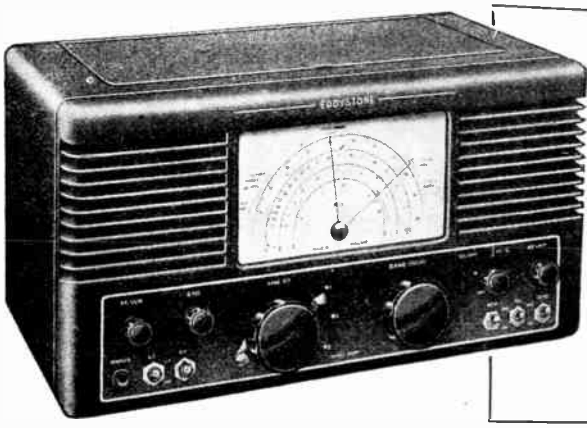
19. **Belling-Lee** Adjustable Plug and Socket for Co-axial Cable ... ... " 3/-
20. **Eddystone** Feed-through Insulator, No. 1018, 2¼in. long ... ... " 2/6



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Specifically designed for Amateur Band Communications Coverage 31—1.7Mc/s. "The first British design worthy of the British amateur." *Vide* "S.W. Magazine."
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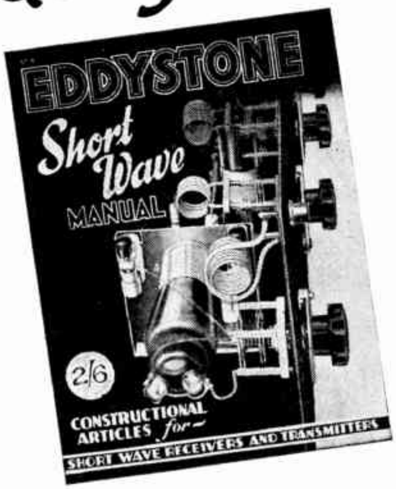
Again published — the Eddystone Short Wave Manual



A new and improved edition of this popular publication that possesses such an intimate appeal for every "Ham" and short-wave constructor has just been published and is available at all Eddystone Registered Dealers. This new Eddystone Manual is larger than the last and contains, in even greater detail, highly interesting constructional articles on how to build a Short Wave Battery Receiver, detailed instructions to make a one-valve V.H.F. Pre-selector, all information to construct a 3-valve V.H.F. Straight Receiver, precise data to produce a 60 Megacycle Crystal Controlled Transmitter, Heterodyne Frequency Meter, notes on aerial systems, etc.—in short, a mine of information you will find most helpful. Contact your Eddystone Retailer and secure YOUR copy now.

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Quantity runs would be required.

Your enquiries will be welcome and receive our energetic attention.

JARRETT, RAINSFORD & LAUGHTON LTD.,
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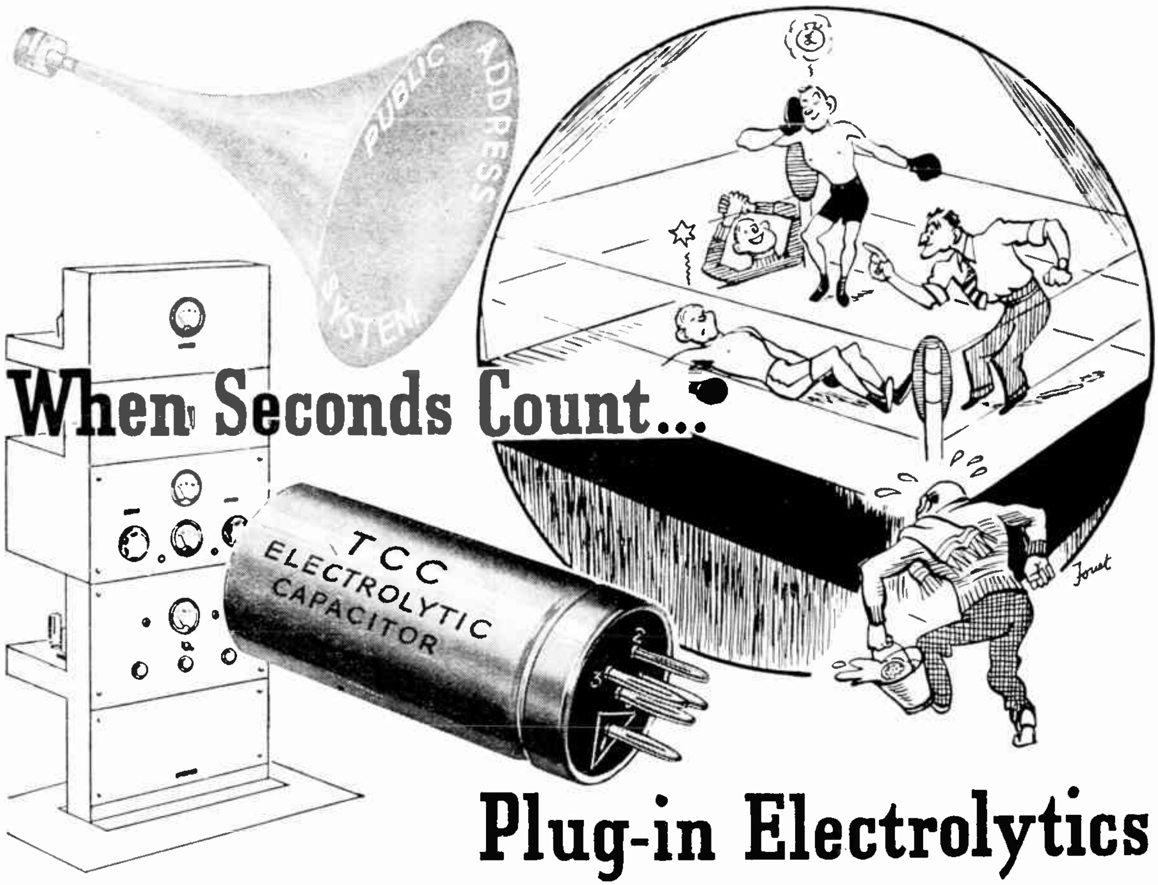

When Seconds Count...

Plug-in Electrolytics

RANGE		
Capacity MFDS	*Peak Working Vol s*	*Re'ail Price*
SINGLE SECTIONS		
16	500 (600v. Surge)	11/-
32	450 (550v. Surge)	12/-
100	250	13/6
250	100	13/6
500	50	13/6
1000	25	13/6
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8-8-4	500 (600v. Surge)	15/-
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We show above the range at present standardised in an aluminium can measuring 3¼" × 1¾", fitted with 5-pin valve base. This list will be added to from time to time, according to demand.

From being the wayward child, the Electrolytic Capacitor, as a result of continuous research and the rigours of hard usage under years of active service conditions, has become the model offspring in the matter of reliability and efficiency.

Even so, accidents must and will happen, and particularly at public meetings and functions it is vital to be able to locate and correct a cause of breakdown instantly . . . or even before it happens.

It can be more than a mere inconvenience to have to locate by test a defaulting capacitor, disconnect from the wiring and replace with a new one. The advent of the T.C.C. Plug-in Electrolytic reduces such anxieties to almost nil and the replacement time to a matter of seconds. It now takes no longer to replace than a valve.

Although the present-day dependability of T.C.C. productions is such that you may never have to do this, you should be prepared for the time. . . .

WHEN SECONDS COUNT.

TCC

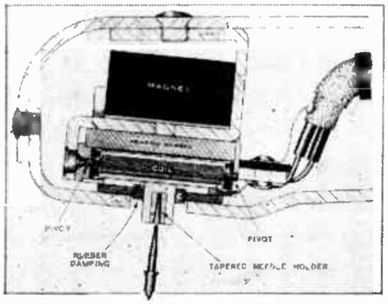
CAPACITORS

THE TELEGRAPH CONDENSER CO., LTD.
RADIO DIVISION
NORTH ACTON · LONDON · W·3 Telephone, ACORN 0061

It's easy to make Pick-ups — if you know how.

The know-how in the manufacture of

Lexington
MOVING COIL PICK-UPS



is the result of long experience and precision watch-making standards which give a finely constructed instrument the details of which are shown in the sectional diagram.

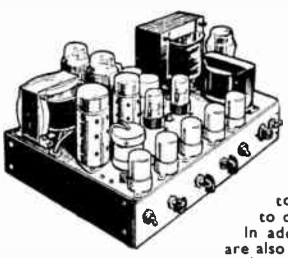
DE LUXE MODEL ● Robust design. Accidental dropping on record will not damage Pick-up ● Extremely low moment of inertia (80 milligrams total weight of movement) ● Pure sine wave with no harmonic distortion ● Automatic needle or sapphire changing opens new fidelity field to the amateur ● Can be used with normal record changer without fear of damage. Price (without sapphire) **£5.10.0.** plus 24/6 P.T.

PLUG-IN HEADS Available in both junior and De Luxe types to fit Collaro and Garrard arms, thus providing easy change-over from Magnetic types. Input conversion may be required. (See our Technical Brochure.) Price **49/6**, plus **11/-** P.T. Separate Ejector for De Luxe type, **30/10**, plus **6/10** P.T.

Sapphire Needle with specially tapered shank, **15/3** (incl. P.T.)

PRE-AMPLIFIERS having an inverse of the recording characteristic incorporated are available for use with pick-ups. These are necessary with some amplifiers. Price complete with valve and input Transformer, **£6.1.0.**

Announcing The NEW LEXINGTON
15-WATT HIGH FIDELITY
AMPLIFIER



Designed in our laboratories for use with our own Pick-ups, also as an Audio-channel for high quality local station radio feeder units.

The amplifier is available completely constructed or the necessary circuit diagrams and technical details can be supplied to technical amateurs who prefer to do their own construction.

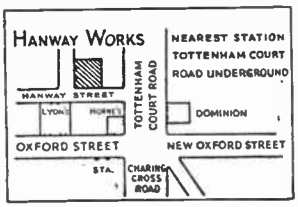
In addition technical details and circuit are also available showing the construction of a high quality **RADIO FEEDER UNIT** incorporating local stations and television sound bands for use with the above amplifier, making a perfect combination for the connoisseur.

Prices and details of the above will be sent upon request.

This service is introduced at the request of the many satisfied users of our Pick-ups.

***Illustrated Technical Brochure** upon request.*

Export and Trade Enquiries invited.



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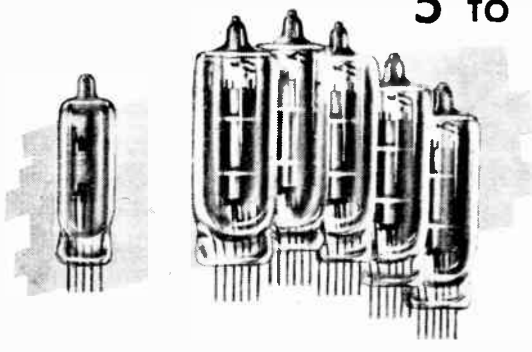
RAYTHEON CONTRIBUTIONS to development of Hearing Aids

Little valve outlasts big one...
5 TO 1



Pictured above is the latest Raytheon Flat Hearing Aid Tube . . . the CK512AX . . . and a group of the earliest Raytheon Hearing Aid tubes.

Apart from the improvement in hearing qualities, just look at the difference in size ! Though less in height and of much smaller cross section, the present Raytheon Flat Valve provides five times the life.

This is but one of many developments which have made Raytheon the leading Hearing Aid Valve . . outnumbering all other makes combined by nine to one !

Ask for complete information. Address your inquiry to Submarine Signal Company (London) Ltd., Artillery House, Artillery Row, London, S.W.1, England, or to :

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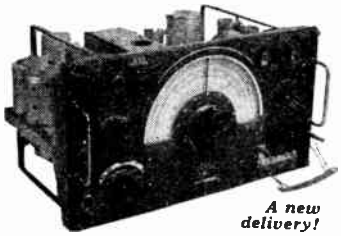
LONDON CENTRAL RADIO STORES

Special Offer of Ex-Govt. Receivers, etc.

10-VALVE COMMUNICATION RECEIVER—Type R1155



A new delivery!

These sets are equal to new, need only a power pack for immediate use (see "W.W.," July, 1946). Freq. range 7.5 mc/s. or 1,500 kc/s., complete with 10 valves, including magic eye. Enclosed in strong metal box **£15**
Each receiver is aerial tested.
Carriage and packing 7/6 extra. No C.O.D.

POWER-PACK 220-250 v. A.C. for above is available to CALLERS ONLY

Type Demolition Mk. 1. Ex-ARMY TEST SET—NEW

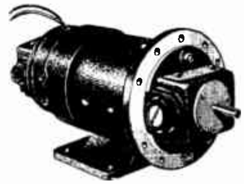
For circuit continuity and general testing. In hardwood carrying case. Carriage paid **£3.10.0**

Type R1147B 7-VALVE U.H.F. RECEIVER Range approx. 200 megacycles

A Real Opportunity!

Beautifully constructed and fitted with micro-condenser drive. Valve type two EF50, two EF36, one each EBC33, RL7, RL16. In black metal case 8 × 7 × 6in. Set, complete, with valves **£2.7.6**

FRACTIONAL H.P. A.C. MOTORS
Converted from ex-Govt. Generators



Brush type 220-250 v. 50 cycles approx. 5,000 r.p.m. Overall diam. 10 × 4in. ¼in. spindle extends 1in. both ends. Post 2/6 extra. **37/6**

AIRBORNE G.P. TRANSMITTERS
Type 1154. A few only to clear.

Complete with 4 valves. Frequency coverage, 500 kc/s, 200 kc/s, 10 mc/s, 3 mc/s, 2.35 mc/s., 8 mc/s., 2.5 mc/s. Power input 1,200 v., 200 m/a. H.T. 6 v. 4 amp., L.T. Chassis size, 15in. × 13in. × 8½in. In metal cabinet. Supplied in strong wood case, with metal bound corners and carrying handles, easily adapted for Amateur use. Less Power Pack **£5.17.6**
Carriage and Packing 10/- extra.

Ex-R.A.F. CAMERA MOTORS

Dimensions 3" × 2" × 1¼" 12v. and 24v. **8/6**

PULSE MODULATOR AND MIXER W6331

Valves: two 6J5, three VR66, one VR65, one EB34, and Rectifier 5U4. Transformers, resistances, condensers, etc. **47/6**

POLARISED RELAYS

115 ohms + 115 ohms. 6in. × 3in. **6/-**

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24 v. D.C. Input, 230 v. 50~A.C., 75 watts Output. Complete with voltmeter and controls. Silent running. Useful for bungalows and yachts. Housed in metal cabinet. For callers only. **£12.10.0**

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Consisting of 6in. diameter Electrostatic C.R. Tube, 7 valves including four EF50, potentiometers, resistances and other associated components. In metal cabinet 10 × 8 × 7½in.
Bargain price **£3.7.6**

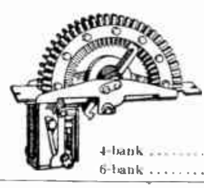
Super Quality Heavy Duty TWIN-ELEMENT SLIDING RESISTANCES

5.4 ohm at 20 amp.	47/6
12 ohm at 10 amp.	39/6
70 ohm at 5 amp.	35/-
Single Element 14 ohm at 5 amp.	13/6

ELECTRO MAGNETIC COUNTERS

Ex-G.P.O. every one perfect, electro-magnetic, 500 ohm coil, counting to 9,999, operated from 25v.-50v. D.C., many industrial and domestic applications **5/6**

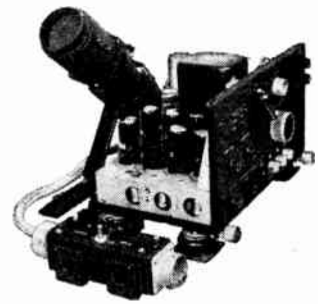
TELEPHONE LINE or UNISELECTOR SWITCHES



4- or 6-bank, 26 constants. Have various applications including automatic tuning, circuit selection, etc. Operates on 25-50v.
4-bank 28/6
6-bank 30/-

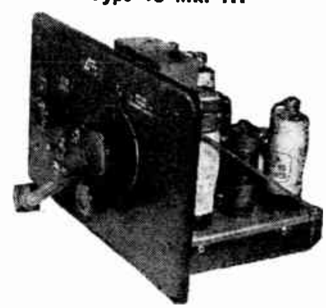
● ***We do not issue lists or catalogues***

Model *AN/APA-1. Ex-U.S.A. AMERICAN AIRCRAFT RADAR UNIT



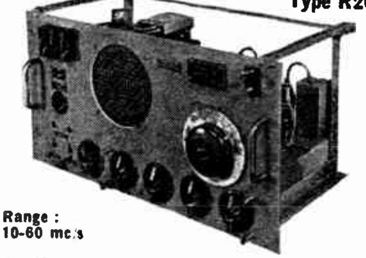
115v. 500 cycles. Complete with 3in. Cathode Ray Tube, 11 valves, Power pack, etc. In black crackle metal case. Brand new and boxed. With full instructions. Carr. paid **£4.10.0**

4-VALVE SUPERHET RECEIVER CHASSIS
Type 18 Mk. III



Range 6-9 mc/s. Complete with valves, 465 KC. IF. Carr. paid **37/6**

6-VALVE SHORT-WAVE RECEIVER
Precision-built Communication Type
Type R208



Range: 10-60 mc/s

Suitable for AC 100-250 v. or 6-v. battery operation. Metal rectifiers, B.F.O., Built-in Speaker, Super Slow motion dial. Provision for phones, etc. A real super job in grey metal cabinet. Complete with Valves and Vibrator ready to use **£18.0.0**
Carriage and packing 12/6 extra.

LONDON CENTRAL RADIO STORES, 23, LISLE ST. (GERrard 2969) **LONDON, W.C.2**
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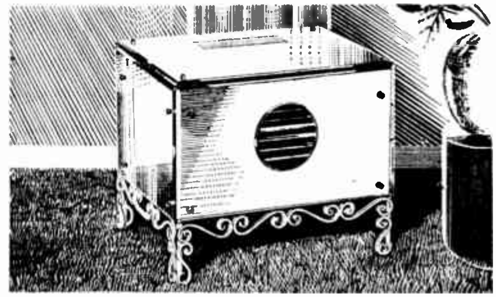
YOUR CHOICE for QUALITY

Manufacturers of high quality Broadcast Receivers and Radiograms designed for Home and the Export Market. The Export Models have fully tropicalised components, achieving unsurpassed short-wave performance.

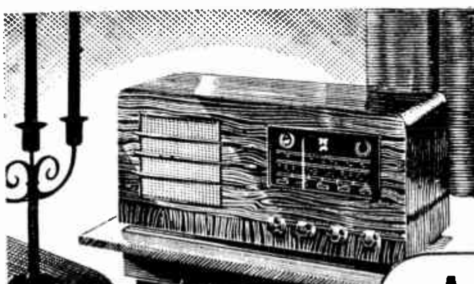
Special dials supplied for any country

PRICES AND FULL PARTICULARS ON REQUEST



CHAIRSIDE MODEL A450

The housing of this Receiver is unique in that it is contained in a bevelled plate-glass mirror cabinet, fitted to a wrought iron framework finished in Cream enamel. It embodies all the latest technical developments for easy handling, range and clarity of reception, and provides not only a first-class radio but an attractive piece of furniture which can replace a Chairside Table and will harmonise with any surroundings.



SYMPHONY MODEL A420

This new Receiver embodies the very latest technique in construction. The cabinet is richly veneered in Walnut with a cross banding of Macassar Ebony. Clearly readable edge-lit dial with an 8 in traverse magic eye and 2-gear control. Instant unerring selection of the required frequency range. Automatic volume control and an I F trap are incorporated in the circuit. Sockets are provided for gramophone pick up and extension speaker.

Allander Radio Receivers were chosen by the Council of Industrial Design for "ENTERPRISE SCOTLAND" Exhibition, 1947.

ALLANDER INDUSTRIES LTD.
48, Avenue St. Bridgeton, Glasgow, Scotland.

ALLANDER

UNREPEATABLE!!!

TRIPLETT
LATEST MULTI-RANGE
METER

The Finest 'Ham' Meter made

Designed exclusively for Amateur use. Supplied Complete with black hide carrying case, at less than to-day's price for a meter without any of the following features :—

(1) The Meter is 1,000 ohms per volt.
(2) Its self-contained batteries allow of accurate measuring from as low as ½ ohm to ½ megohm. Even higher ranges can be obtained with the use of external batteries.
(3) Current ranges are 10,100 and 500 m/A.
(4) Volt ranges are 10, 50, 250, 1,000 and 5,000 volts at 1,000 ohms per volt, both A.C. and D.C.

Many other brand new bargains are given in our **LIST No. 5.** Price 2½d., post free.

CALLERS *should watch our windows for many lines, such as Tubular Steel U.S.A. Masts, etc. Quantity available does not justify our including them in our current list.*

With this Meter there is no metering problem that you cannot tackle on the spot and with one instrument.

It is complete with test leads, fine black hide carrying case, and in its makers' original carton. Supplies are limited.

OUR PRICE WHILE THEY LAST IS

ONLY 9 GUINEAS

Hurry up, there cannot be any more.

RADIOMART
G5NI (B'HAM) LTD.

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SOUND SYSTEMS USED

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BIRMINGHAM SOUND REPRODUCERS LTD.

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M.W.88.

There's a size for every job in the S.P. range of metallised bushes

Please write for Catalogue No. 25.

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STOURPORT ON SEVERN, WORCS. Telephone: Stourport 111. Telegrams: Steatain, Stourport.

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GARDNERS RADIO LTD ANNOUNCE–

21 *entirely new types*

INCREASING THE STANDARD RANGE TO 66 POWER TRANSFORMERS AVAILABLE FOR PROMPT DELIVERY

Type No.	Specification		Price Retail
R.172	Secondary	250—0—250 v. 250 mA ... ... 0—4—5 v. 3.5 amps. 0—4—6.3 v. 4.0 amps. 0—4—6.3 v. 4.0 amps.	75/-
R.175	Secondary	300—0—300 v. 120 mA ... ... 0—4—5 v. 2.5 amps. 0—4—6.3 v. 5 amps.	51/-
R.178	Secondary	300—0—300 v. 250 mA ... ... 0—4—5 v. 3.5 amps. 0—4—6.3 v. 4.0 amps. 0—4—6.3 v. 4.0 amps.	79/6
R.180	Secondary	350—0—350 v. 250 mA ... ... 0—4—5 v. 3.5 amps. 0—4—6.3 v. 4.0 amps. 0—4—6.3 v. 4.0 amps.	81/-
R.183	Secondary	400—350—0—350—400 v. 120 mA ... ... 0—4—5 v. 3.5 amps. 0—4—6.3 v. 4.0 amps. 0—4—6.3 v. 3.0 amps.	67/6
R.187	Secondary	425—0—425 v. 180 mA ... ... 0—4—5 v. 3.5 amps. 0—4—6.3 v. 4.0 amps. 0—4—6.3 v. 3.0 amps.	78/6
R.190	Secondary	450—400—0—400—450 v. 180 mA ... ... 0—4—5 v. 3.5 amps. 0—4—6.3 v. 3.0 amps. 0—4—6.3 v. 3.0 amps. 0—4—6.3 v. 2.0 amps.	91/-
R.193	Secondary	450—400—0—400—450 v. 250 mA ... ... 0—4—5 v. 3.5 amps. 0—4—6.3 v. 4.0 amps. 0—4—6.3 v. 4.0 amps. 0—4—6.3 v. 3.0 amps.	107/6
R.195	Secondary	500—400—0—400—500 v. 180 mA ... ... 0—4—5 v. 3.5 amps. 0—4—6.3 v. 3.0 amps. 0—4—6.3 v. 3.0 amps.	89/6
R.188	Secondary	500—0—500 v. 250 mA ... ... 0—4—5 v. 3.5 amps. 0—4—6.3 v. 4.0 amps. 0—4—6.3 v. 4.0 amps. 0—4—6.3 v. 3.0 amps.	127/6
R.157	Secondary	1500—1250—0—1250—1500 v. 180 mA ...	165/-
R.159		1500—1250—0—1250—1500 v. 250 mA ...	225/-
R.162		2000—1750—0—1750—2000 v. 250 mA ...	315/-
L.415		0—4—5—6.3 v. 3.5 amps.	31/6
L.416		0—4—5—6.3 v. 6.0 amps.	34/-
L.460		4 v. 10 amps. C.T.	34/6
L.463		6.3 v. 8 amps. C.T.	36/-
L.466		7.5 v. 5 amps. C.T.	33/6
L.470		0—4—6.3 v. 2 amps. C.T. ... ... 0—4—6.3 v. 2 amps. C.T.	35/-
A.406		2.5 v. 10 amps. C.T. (2 kV wkg.)	40/-
A.402		4 v. 6 amps. C.T. (2 kV wkg.)	40/-

Prices now subject to 10 per cent. increase.

● THE COMPLETE NEW RANGE OF 66 SOMERFORD POWER TRANSFORMERS IS DESCRIBED IN OUR REVISED LIST L.M.T.4, WHICH WILL BE GLADLY SENT ON REQUEST.

GARDNERS RADIO LIMITED
SOMERFORD • CHRISTCHURCH • HANTS

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BRITAIN'S FOREMOST REPRODUCERS

Reproducers and Amplifiers Ltd.,
WOLVERHAMPTON,
ENGLAND.

SEND TO VALLANCE'S FOR "Q-MAX"

VHF	Converter	£19	19	0
A5W6	Superhet Short Wave 6 (excldg. Speaker) including P.T.	£34	16	1
AD4	All Dry SW4 (excl. Batts., Coils, Speaker) including P.T.	£15	19	5
ADC	Set of Coils for AD4	£2	5	6
SMDA	Slow Motion Dial		15	6
SMDAS	Scale for SMDA		3	0
SMDAB	Ball Drive for SMDA		3	3
SMDB	Super Slow Motion Dial	£3	6	0
SMDBS	Scale for SMDB		6	6
SMDBL	SMDB less Slow Motion Drive	£1	9	6
C7960	Metal Cabinet	£4	14	6
C6760	Metal Cabinet	£3	13	6
BID90	Instrument Dial... per doz.			9
BIP40	Instrument Name Plates ... per doz.			6
BD275	Engraved instrument dial and knob		4	3
B275	Dial only		2	3
BD400	Engraved instrument dial and knob		6	9
B400	Dial only		3	6
BDV400	Vernier for BD400		1	0
CC18	Chassis Cutter 1⅛in.		10	6
CC14	Chassis Cutter 1¼in.		12	6
CC12	Chassis Cutter 1½in.		12	6
FD55	Flexible Driving Shaft 5½in.		6	0
FD58	Flexible Driving Shaft 8½in.		6	6
TCI	Tank Coil Unit, Mk. I	£3	9	6
TCII	Tank Coil Unit, Mk. II	£6	13	0
C7	Coil for Tank Unit, 7 m/cs		15	6
C14	Coil for Tank Unit, 14 m/cs.		14	6
C28	Coil for Tank Unit, 28 m/cs.		12	6
C56	Coil for Tank Unit, 56 m/cs.		10	6
CL	Coil Links 1, 2, or 3 turns		3	0
CN	Neutralising Condenser		11	6
AW	Absorption Wavemeter	£1	15	0
AWR2	7 m/cs. Inductance for AW.		3	9
AWR4	14 m/cs. Inductance for AW		3	9
AWR5	28 m/cs. Inductance for AW		3	9
S	Meter for AR88	£2	19	6

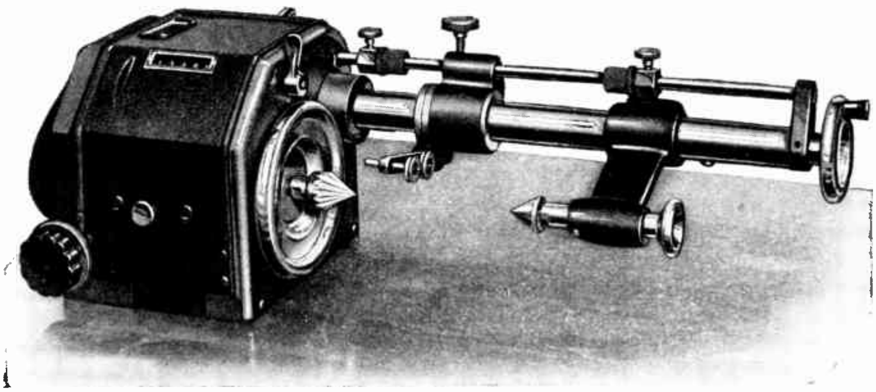
Please send your orders and enquiries for our prompt attention. All goods well packed and despatched C.W.O. or C.O.D. whichever suits you better. When sending C.W.O. please include sufficient for packing and postage.

VALLANCE'S, 144 Briggate, Leeds 1

Staff Call Signs: G8SX—G2HHV—G3ABD—G3AHV—G3BDD.

THE NEW KOLECTRIC HIGH SPEED PRECISION AUTOMATIC COIL WINDING

Machine Type A1/1



A few features:

Totally enclosed headstock.

Ease of operation and setting.

Winding of 2 coils simultaneously.

Clear wire guage indicator.

Wire feed from back of coil—ease of paper insertion.

Hand brake wheel.

Carriage setting handle.

Enclosed drive, with pedal control.

Write us for full information of this NEW DEVELOPMENT IN COIL WINDING.

KOLECTRIC LTD. 20, Avonmore Rd., LONDON, W.14

DAWE SOUND LEVEL METER

Suitable for all types of sound measurement ranging from the volume of noise of a whisper to that of a factory hooter. Simple to operate; completely self-contained; rugged and portable.

WIDE RANGE—34 to 130 decibels.
NON-DIRECTIONAL SOUND-CELL TYPE MICROPHONE — removable for special applications.
SLOW-FAST METER.
INTERNAL CALIBRATION SYSTEM.
THREE WEIGHTING NETWORKS
COMPLETE ABSENCE OF INDUCTANCES in construction enables accurate readings in presence of magnetic fields.

DAWE INSTRUMENTS LTD., HARLEQUIN AVE., GT. WEST ROAD, BRENTFORD, MIDDX. *Phone:* EALING 1850

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Seamless, one-piece, metal bellows . . . formed in one continuous operation by a process unique in this country, with a uniformity of wall-thickness unobtainable by any other method . . . No annealing, no spinning, no localised strain or thinning; none of the limitations of metallic diaphragms.

These bellows, though no thicker than paper—the walls range from 4/1000" to 7/1000"—are tough, resilient, and combine the characteristics of a coiled compression spring, a packless gland, and a non-ferrous hermetically sealed container. Every bellows is pretested during forming and has a high degree of uniformity of life, performance and reliability in operation. Available in root diameters of ⅜" to 3", outside diameters $\frac{9}{16}$" to 4½".

Write for the Hydroflex Brochure Y

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Refrigeration
Temperature Control
Air compressors
Water pumps
Paper machines
Gland seals
Thermostatic & pressure operated appliances

Drayton Hydroflex **METAL BELLOWS**

Drayton Regulator & Instrument Co. Ltd., West Drayton, Mdx.

PREMIER RADIO COMPANY

MORRIS & CO. (RADIO) LTD.

ALL **POST** ORDERS to 167 LOWER CLAPTON RD., LONDON, E.5. 'Phone : Amherst 4723.
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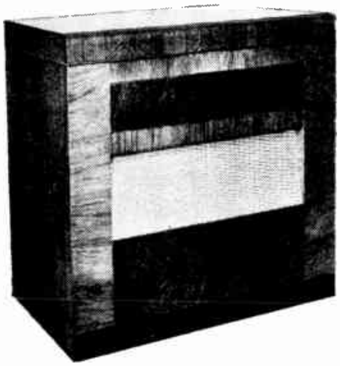
Terms of Business : Cash with order or C.O.D. over £1. *Send 2½ stamp for new Nov. 1947 list.*

RADIOGRAM CABINETS



Dignified appearance and good workmanship. Size 31½in. high, 18½in. deep, 33 wide. French polished, veneered walnut. Price **£26.** Also available complete with electric motor, auto stop and magnetic pick-up. **£34 5s. 0d.**
Ditto with Rothermel Crystal Pick-up, **£36 2s. 1d.**, or with 8 record-mixer changer, **£45 7s. 6d.**

SUPER OUTPUT TRANSFORMERS. By means of a series parallel arrangement wherein the maximum winding is used for each ratio extremely high efficiency is obtained. Any valve single or pushpull may be matched to any voice Coil (2 to 30 ohms) type Mo. 15.15 watts, **30/-.**

5-VALVE SUPERHET RADIO. Employ CCH35 EF39, EBC33, CL33, CY31 valves; operate on 100-250 volts AC/DC mains. Cover 13-40, 40-100, 200-550 meters. Gram position on wave change switch. EXT L/S terminals, 8-inch energised Speaker; dial aperture 12 × 4in.; enamelled steel cabinet, 18in. high × 15in. wide × 9in. deep. Manufactured by Portogram Ltd. for Navy Welfare Centres. A fortunate purchase enables us to offer these fine sets at **£12 10s.**, including Purchase Tax. Packing and carriage 10/- extra. Strongly recommended as a Radiogram Chassis in conjunction with Cabinet, illustrated above.

METERS. A huge purchase of military surplus meters allows us to offer the following bargains. Best makes Bakelite cases, prices are approx. ¼ original cost.

Range	Ext. Diam.	Basic Movement	Fitting	Type	Price
300 v.	3½"	× M/A	Flush	M.I.A.C.	**12/6**
500 M/A	3"	—	Proj.	M/C D/C	**12/6**
40 v.	2"	5 M/A	Flush	M/C D/C	**7/6**
2½A	2"	—	Flush	Thermo	**7/6**
4A	2½"	—	Port	H. Wire	**7/6**
3KV	3½"	2½ M/A	Flush	MC/D/C	**20/-**
20A	2"	25 M/A	Flush	M/C D/C	**7/6**
40A	2"	12½ M/A	Flush	M/C D/C	**7/6**
25A	3½"	5 M/A	Flush	M/C D/C	**7/6**
25A	3½"	25 M/A	Proj.	M/C D/C	**7/6**

OSCILLOGRAPH POWER UNIT KITS. Input 230 v. include transformer, metal rectifiers, voltage doubling and smoothing condensers.
Type 409, output 900 v. **25/-**
Type 410, output 1,800 v. **25/-**

STANDARD OUTPUT TRANSFORMERS. Match any push-pull peutodes to 3 or 15 ohms. Handles 8 watts, **17/6.**

AIR-DIELECTRIC TRIMMERS. Super-midget variables ceramic insulation, screw-driver adjustment. 25, 50 or 100 pF **1/-.**

VARIABLE CONDENSERS. Ceramic insulation. 2-gang .0005, **8/6** ; 3-gang .0005, **10/-** ; 4-gang .0005, **10/-** ; 1-gang .0005, **5/-** ; 2-gang .00016, **5/-** ; 3-gang .00016, **10/-** ; 3-gang .0003, **10/-.**

GRAMOPHONE AMPLIFIER KIT. A complete kit of parts to construct a good quality mains-driven 2½-watt gramophone amplifier. May be used with any pick-up. Complete with circuit, **£3 5s.**

MIDGET RADIO KITS

MIDGET RADIO KIT. Build your own midget radio. A complete set of parts, including valves, loudspeaker and instructions. In fact, everything except cabinet necessary to build 4-valve Medium and long Wave T.R.F. radio operating on 200-250 v. mains, A/C or D/C. Valve line-up, 6K7, 6J7, 25A6, 25Y5. Wavelengths covered 200-557 and 700-2,000. Size 10 × 6 × 6in. Completely drilled chassis. Price, including tax, **£7 7s. 6d.**

SUPERHET MIDGET RADIO KIT. A complete kit of parts for a 5-valve superhet. Covers 16-50 and 200-557 metres, AC/DC 200-250 v. 6K8, 6K7, 6Q7, 25A6, 25Y5. Size, 10 × 6 × 6in. Completely drilled chassis. Price including tax, **£8 5s.**
An attractive brown bakelite cabinet, as illustrated above, can be supplied for either kit at a cost of **25/-.**

MAINS TRANSFORMERS. All input, 230 v. 50 c. Type 30, output 30 v. 4 a., **20/-** ; Type 31, output 40 v. 3 a and 104 v. 1½ a. (auto-wound), **21/-** ; Type 32, 700 + 700 150 m/A, 1,000 v. 30 m/A (half wave), 4v. 1 a. 4 v. 3-5 a., **40/-** ; Type 33, 32, 34, 36, 38 v. at 2 a., **15/-.**

R.A.F. 1155 Receivers. Complete with valves, **£12 10s.** to callers. Packing and carriage, 30/- extra. 230v. A/C powerpack for same, **50/-.**

CRYSTAL RECEIVER KIT. Complete with phones. The ideal Christmas gift for the schoolboy, **10/-.**

WEARITE TUNING PACK. A super job. Completely wired with padders and trimmers. Long- medium- and short-waves. Iron core coils, **42/-.**

FERRANTI 1 MILLIAMP METERS. 3½in. external diameter, flush mounting, with self-contained Westinghouse bridge rectifier. Scale marked 0-10 volts with fifty divisions, fitted in well-made wooden box 6 × 5 × 5in., **35/-.**

2-VALVE SHORT-WAVE BATTERY KIT. A complete kit of parts for a 2-valve receiver, covering 15-600 metres, including valves, coils, drilled chassis, H.T. and L.T. dry batteries to last approximately 6 to 12 months. A pair of double headphones and full instructions. Price **£3 10s.** An extra coil can be supplied covering 600-1,900 metres at **4/-.**

SUPERHET TUNING PACKS. Completely wired and aligned. 13-40, 40-120, 190-570 metres. R.F. stage, 465 k.c.: 9 connections only. Complete with 3-gang condenser, calibrated, engraved Perspex dial, and S.M. drive. Litz wound polystyrene insulation, permeability tuned I.F.'s, 7 k.c. band width. Price complete **£3 17s. 6d.**

DENCO C.T.3 COIL TURRET COVERS. 15 to 42 m.cs. in six bands. Consists of completely wired coil pack for communication receiver, including trimmers, padders, scales, knobs. Mechanical bandspread, I.F. 1.6 m cs. R.F. stage, iron cores, polystyrene insulation. Circuits available at **1/6.** Price **£7 0s. 10d.**

LOUDSPEAKERS. 5in. P.M., **15/-**, with trans., **20/-.** 6in. P.M., **17/6**, with trans., **22/6.** 8in. P.M., **20/-**, with trans., **25/-.** 9 in. P.M. 15 Ω 6 watt, **38/-.** 10in. P.M., 15 Ω 6 watt, **47/6.** 10in. P.M. 3 Ω 4 watt, **30/-.** 12in. P.M. 15 Ω 12 watt, **£5.** 12in. P.M. 15 Ω 12 watt twin-cone high fidelity, **£8 8s.** 12in. P.M. 20 watt, **£7.** 6in. 1,140 Ω Field with trans., **27/6.** 10in. 2,100 Ω Field 3 Ω 6 watt, **27/6.**

BABY ALARM KIT. Consists of a complete kit of parts for a mains-driven amplifier, microphone and Midget speaker, to enable sound of baby's breathing or crying to be heard in any room. Complete with circuit. **55/-.**

CONDENSERS. First grade oil-filled condensers at a ridiculous price. 1 M.F. 1,000 v.w., **1/-** ; 1 M.F. 2,500 v.w., **5/-** ; 1 M.F. 5,000 v.w., **7/6** ; 2 M.F. 600 v.w., **1/9** ; 2 M.F. 1,000 v.w., **2/6** ; 4 M.F. 1,000 v.w., **5/6** ; 4 M.F. 750 v.w., **4/-** ; 4 M.F. 2,000 v.w., **12/6.** D/C to A/C converters. Type 1, input 12 v. D/C. Output, 230 v. 50 c. 75 w., **£6.** Type 2, input 18/24 v. D/C. Output 230 v. 50 c. 100 w., **£5.** Type 3, input 100 v. D.C. Output 230 v. 50 c. 200 watts, **£8.**

PREMIER PEDESTAL PLAYING DESKS

A well made mahogany finished pedestal cabinet, containing a quality electric gramophone motor and pick-up in upper compartment, and record space in lower. Height, 30in. Width, 16in. Depth, 15in. Price **£18 18s.**

SHORT-WAVE CONDENSERS. High-grade ceramic insulation, super midget type, single gangs available in 10, 20, 50, 75 (75 pf. has double spindle for ganging). Price **2/6.**

2-GANG, in 4, 8, 9.6, 27.1, 50, 75 p.f. Price **5/-.**

WAVE CHANGE SWITCHES. Available with any of following wafers: 2-pole 3-way, 3-pole 3-way, 4-pole 2-way, 2-pole 4-way, 4-pole 4-way, 2-pole 6-way, 1-pole 11-way; 2-pole 5-way: 1 gang, **4/-** ; 2-gang, **5/6** ; 3-gang, **7/-.**

METAL RECTIFIERS

Output Volts	Current	Type	Price
600	40 m/a.	H.W.	**5/-**
280	40 m/a.	H.W. or V.D.	**5/-**
325	65 m/a.	H.W. or V.D.	**5/-**
36	75 m/a.	Bridge	**1/6**
16	1 amp.	Bridge	**12/6**
48	1½ amp.	Bridge	**25/-**
16	5 amps.	Bridge	**30/-**
16	8 amps.	Bridge	**37/6**
4	½ amp.	H.W.	**5/-**

ALUMINIUM CHASSIS. Substantially made of bright aluminium, with four sides.

7 × 3½ × 2in. ..	**4/6**	9½ × 4½ × 2in. ..	**5/6**
10 × 8 × 2½in. ..	**7/-**	12 × 9 × 2½in. ..	**7/9**
14 × 9 × 2½in. ..	**8/3**	16 × 8 × 2½in. ..	**8/6**
20 × 8 × 2½in. ..	**10/6**	22 × 10 × 2½in. ..	**13/6**

TYPE 103 ROTARY TRANSFORMER. Normal rating is 19 v. D/C input. Output, 300 volts 30 m/a and 6.5 volts 3 a. D/C. By applying between 200 and 250 volts D/C to the H.T. output side, the two low-tension windings may be used to charge accumulators. The 19-volt side will charge a 6-volt accumulator at 2-3 amps. the 6.5 side a 2-volt accumulator at 1-2 a. With a 12-volt input to the 19-volt side, 180 v. at 30 m/a and 4 v. at 3 a. may be obtained. With a 6-volt input to the 6.5 side, 160 v. at 30 m/a may be obtained. By extending the spindle which is flush with the frame and applying 200 to 250v. D/C mains to the 300 v. side, the unit becomes a powerful high-speed electric motor, suitable for small drilling machines, etc. Similarly, it may be used with 6 or 12 v. input to the 6.5 v. or 19 v. side. It employs a powerful ring magnet and is of substantial construction, costing originally over **£5.** A fortunate purchase enables us to offer these fine units at **10/-.**

TRANSFORMER CARCASES. Excellent for rewinding, 200 watts, **15/-.** Military surplus tubes, unused and guaranteed, EF50, **6/-** ; EA50, **5/-** ; 6K7, **7/-** ; VU120, **12/6** ; 6SN7, **5/-** ; 6AG7, **5/-** ; 6AC7, **5/-** ; 6H6, **3/6** ; VR150, **7/6** ; 884, **10/-** ; 2050, **10/-.**

SPECIAL OFFER.—High-grade microammeters, F.S.D. 0-500. Scale marked 0-15 and 0-600 (fifty divisions) 500 Ω Resistance. Price **7/6.** Worth **40/-.**

They'll never miss a minute of

CHILDREN'S HOUR

if you rely on

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L.T. ACCUMULATORS

AND

Drydex

H.T. BATTERIES

ISSUED BY
THE CHLORIDE ELECTRICAL STORAGE COMPANY LIMITED

EDX9A

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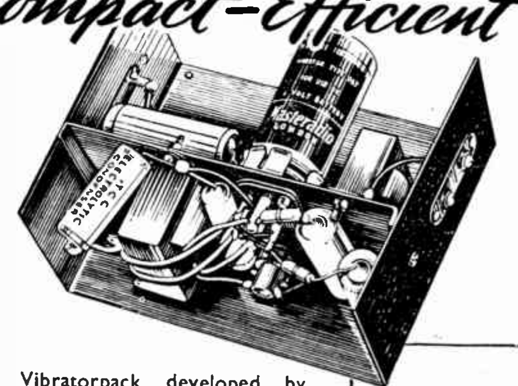

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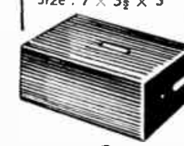

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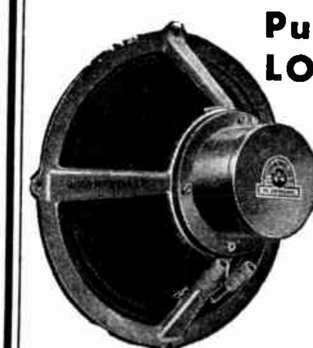

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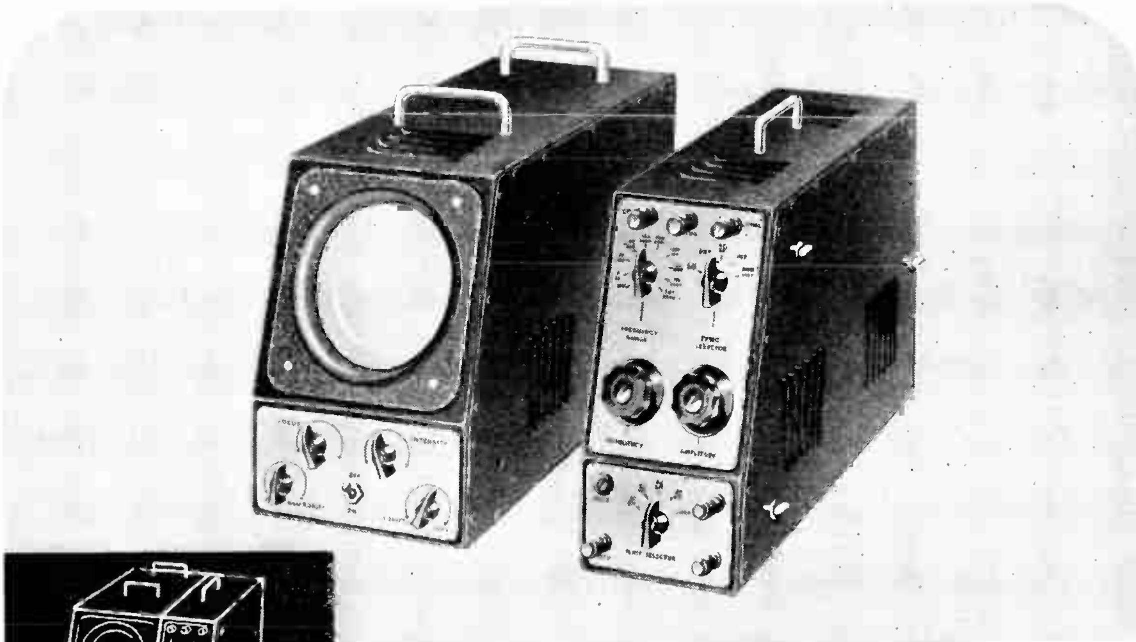

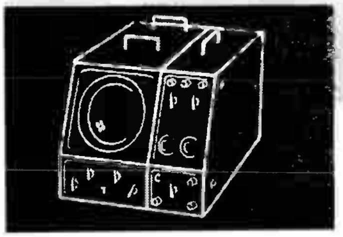

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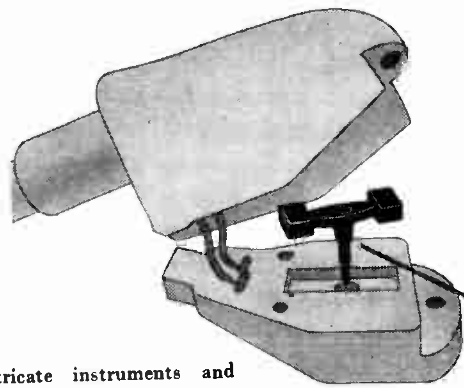

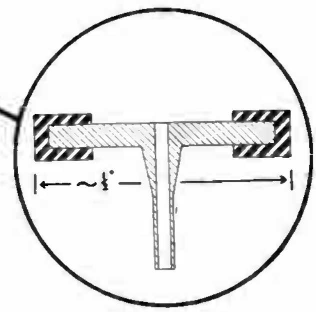

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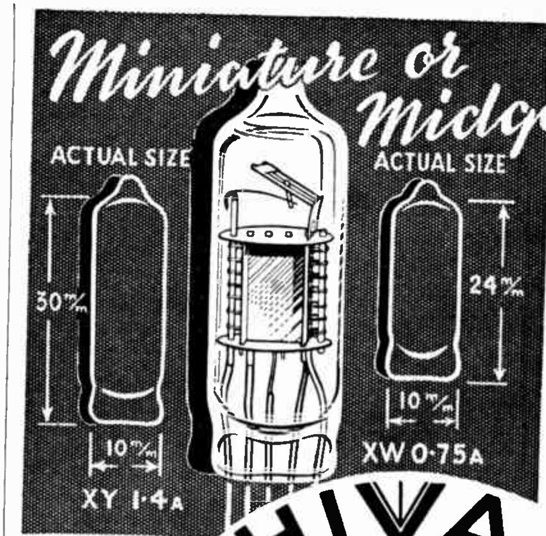

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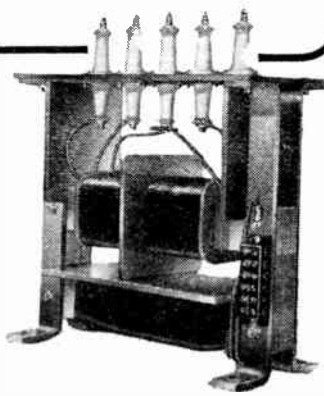

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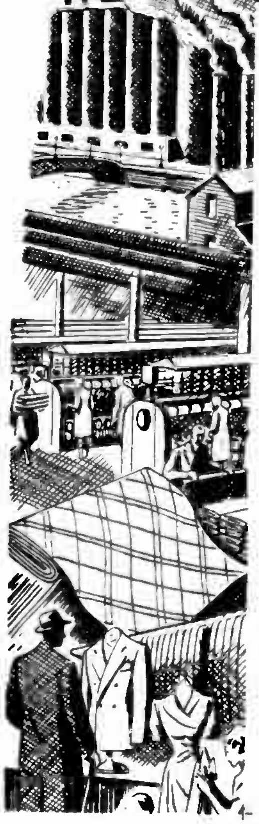

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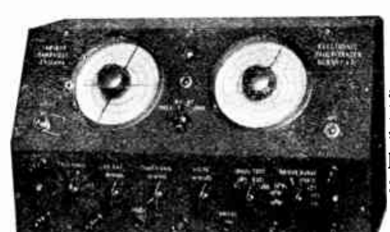

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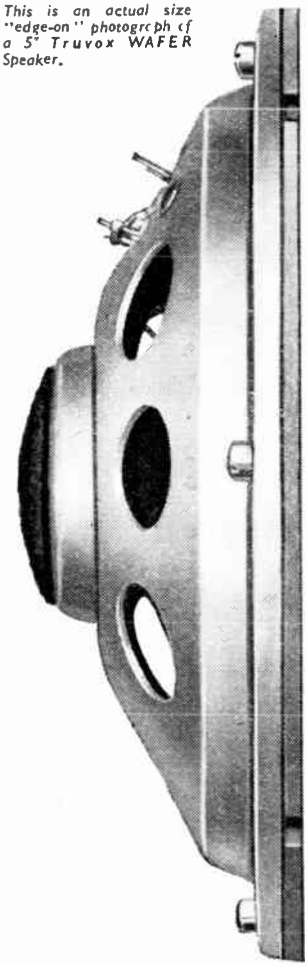

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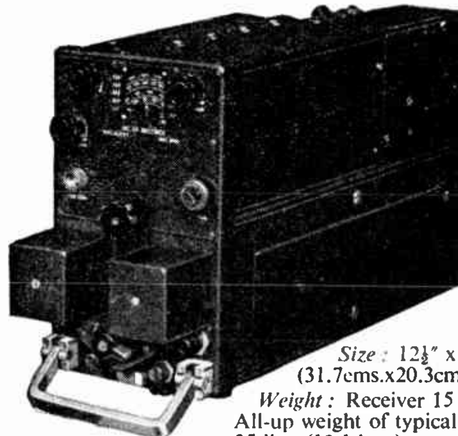

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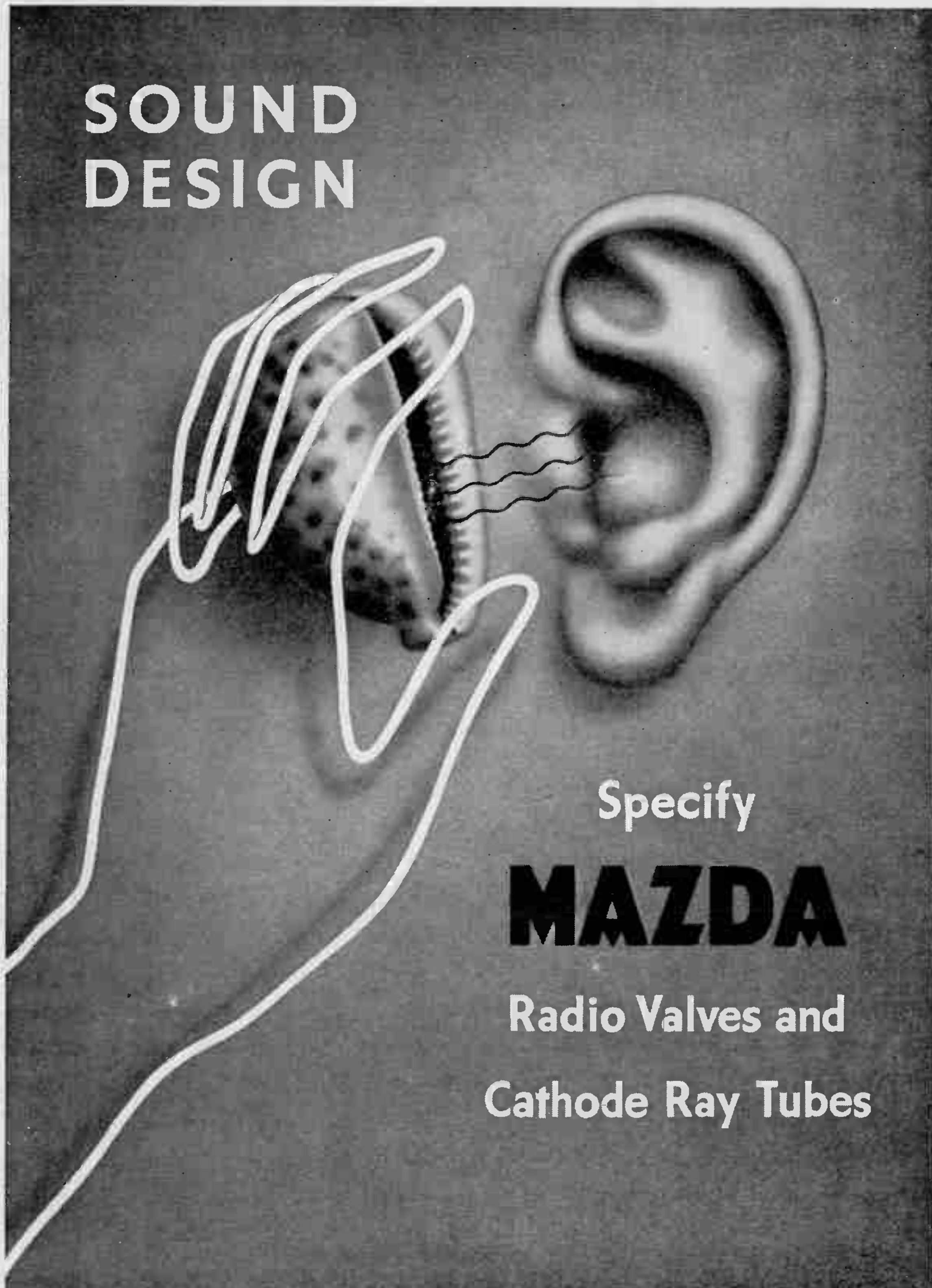
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As many of the circuits and apparatus described in these pages are covered by patents, readers are advised, before making use of them, to satisfy themselves that they would not be infringing patents.

VALVES AND THEIR APPLICATIONS

By M. G. SCROGGIE, B.Sc., M.I.E.E.

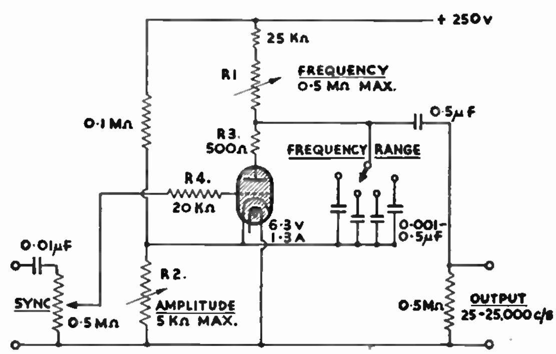
No. 11: Mullard GAS TRIODE EN31

Of the many applications of "soft" triodes, time base generation has always been the most widely used. The main reason for its popularity in that role is its ability to change suddenly from zero to a heavy current at a low voltage, and thereby to discharge a capacitor so quickly that the flyback is accomplished in a very small fraction of the whole cycle. By contrast, a hard valve requires some amplified triggering device to speed up the discharge. and even then is not such a low-resistance " switch."

The explanation, of course, is that directly any appreciable electron current starts to flow through low-pressure gas the molecules are ionized, or split up into electrons and positive ions, forming an electrically-neutral highly-conducting cloud. It is as if the anode were suddenly brought within a microscopic distance of the cathode. There is therefore, negligible space charge for the anode voltage to overcome, even when the current is very heavy. The anode-to-cathode voltage is constant at quite a moderate critical value, depending on the kind of gas enclosed. Although the 33 V drop in the EN 31 is higher than in a mercury-vapour valve, its characteristics depend much less on temperature.

Since the control grid is smothered by the conducting cloud, it ceases to control, until the discharge ends through lack of voltage to maintain it. Its function is then to determine, by the negative bias applied, the anode voltage needed to re-start the discharge, and hence the amplitude of the time-base voltage. In the EN 31, 1 volt of bias is needed for every 35 additional anode volts.

The circuit diagram shows a very simple form of time base generator. It can, of course, be modified to include one of the usual linearizing devices, but except for precise work the stroke is linear enough if restricted to about 30 or 40 V. R1 controls the speed of charge, and R2 the bias. R3 is to limit the discharge to the rated maximum, 750 mA. 2 Ω for every HT volt is well on the safe side. R4 is another limiting resistance, to keep the grid current within 1 mA. The total resistance between grid and cathode should be 0.75MΩ at most; preferably less. Since the bias required for control is only 1-35th of the anode voltage, the heater can be joined to –HT without fear of its voltage to cathode exceeding the rated limits of 0 to –100 V.



Mullard

This is the eleventh of a series written by M. G. Scroggie, B.Sc., M.I.E.E., the well-known Consulting Radio Engineer. Reprints for schools and technical colleges may be obtained free of charge from the address below. Technical Data Sheets on the EN31 and other valves are also available.

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Wireless World

Radio and Electronics

Vol. LIII. No. 11 — NOVEMBER, 1947 — Price 1s. 6d.

MONTHLY COMMENTARY

Reflections on Olympia

IT is easy to decry the whole idea of radio exhibitions; to speak of their ephemeral and valueless glamour; to deplore waste of man-power and material resources at a time of crisis. With some plausibility, one may write off the huge attendances at the recent Show by saying that many visitors went there merely because it was a show, and not because they had any real interest in radio. One may go on to urge that radio is now too complex for the lay public anyway.

To argue in this "superior" kind of way shows a lack of appreciation of the conditions prevailing in our rather irrational world. Some of the criticisms are entirely unjustified on grounds of fact; admittedly the visitors comprised a good sprinkling of habitual exhibition addicts, but, from our own observation the attendance was of high average quality. A very large proportion of those who went to Olympia were seriously interested, and a considerable proportion of them were users or potential users of communication or electronic equipment—not merely of broadcast receivers. The inclusion of exhibits of these classes of equipment has been amply justified.

Without any doubt, the exhibition has been successful in showing that the British radio industry has succeeded, more than most others, in adapting itself to post-war conditions and in producing equipment that bears few visible traces of the prevailing austerity. This is not to say that there is evidence of wasteful lavishness; on the contrary, a virtue is often made of necessity, and methods are sometimes adopted which combine improved performance with reduced consumption of scarce materials. That is real engineering progress. The industry must have convinced everybody that it now plays a worthy part in our national economy, not only internally but as an important contributor of foreign exchange. On the wider issue, the exhibition—directly and through the wide publicity given to it—has done much to show the general public that wireless is something more than a means of distributing entertainment; it is a vital service in itself and an essential ancilliary to many other services of a modern society. As such, it is something to be fostered and encouraged.

Elsewhere in this issue we review in detail the trend of design in the principal classes of exhibits. In considering such matters, there is inevitably a temptation to compare things with those shown at the last exhibition in 1939. In spite of the strides that have been made in electrical design, perhaps the most striking advance is in mechanical construction. Radio has since its inception been weak on this side, but lessons have been learned from the war, and manufacturers have found out how to make components and assemblies both well and cheaply. Even some of the least expensive broadcast sets have attained a standard of execution and finish that was never approached before the war.

Another tendency to be commended is the provision of broadcast receivers for the discriminating user with requirements and tastes not catered for by standardized productions. This tendency has naturally been restricted by present shortages but there are indications that when conditions allow the demand for such sets will be amply met.

The more sympathetic attitude of the Post Office towards applications for licences for communication services is probably responsible for the fact that so many firms have started to produce low-power transmitters and receivers for such purposes. Provided that effective means can be devised for controlling the use of radio by operators of road vehicles, port authorities, towage companies, press correspondents and the many other new users who are envisaged, we welcome this extension of radio. It is interesting and perhaps significant that the sharp line of demarcation between makers of broadcast receivers and communication equipment has entirely disappeared during the war. Many of the larger firms now produce both; it is all to the good that we are tending to become one family.

Push-pull Balance

Effect of Minor Imperfections

By W. T. COCKING, M.I.E.E.

ONE of the more important reasons for adopting push-pull amplification, especially in an output stage, lies in the fact that under ideal conditions all even-order harmonics, introduced by curvature of the valve characteristics, are balanced out and do not appear in the output. In addition to this, the mean anode currents of the valves act in opposition in the output transformer and the core consequently works under better conditions. Because of this transformer distortion is also reduced.

It is important to notice that the push-pull connection only reduces even-order harmonics. Consequently, its use is of value only if the distortion introduced by the valves is predominantly of this kind. This is so with triodes and for long no other valves were used in push-pull.

When operated under optimum conditions for a single output valve, a pentode or tetrode usually introduces more third than second harmonic. The use of a pair of such valves in push-pull then gives relatively little advantage over a pair in parallel, but there is still some advantage, largely because of the improved conditions in the output transformer brought about by the removal of the direct polarizing current.

The distortion introduced by a tetrode or pentode depends very much upon the magnitude of its load resistance, however. With a low value of load the distortion is predominantly second harmonic, just as with a triode, and this distortion tends to decrease as the load is increased, again just as with a triode. Unlike the triode, however, third harmonic distortion grows rapidly as the load resistance is increased. Although small when this resistance is small it greatly exceeds the second harmonic when it becomes high.

When pentodes are used in push-pull, therefore, it usually pays to work with an effective load on each which is much less than the optimum for the non-push-pull case. The third-harmonic distortion is reduced and the second-harmonic distortion is balanced out by the push-pull connection.

While there is no doubt at all about the value of push-pull in both theory and practice, many people realize that the ideal conditions which are usually assumed in theoretical discussions do not exist in practice. They realize, for instance, that the two valves of a push-pull stage are never exactly alike, and they wonder how much the performance is affected by this. Then, again, they know that various balancing schemes are sometimes recommended and they wonder if they are necessary when other amplifiers perform satisfactorily without them.

It is not easy to find answers to questions such as these and very little definite information on the subject has been published. The simplest method of attacking the problem is to express the characteristics of the valves by power series, but even if only a few terms are taken the expressions become very cumbersome, and it is not easy to take the load impedance into account.

The equations in the Appendix show the second- and third-harmonic distortion produced by valves having characteristics which can be represented by cubic equations, ignoring the effect of the load. The distortion for a pair of valves in either parallel or push-pull is given. The signal voltages are represented by e_1 for one valve and $e_2 + e_3$ for the other; e_1 and e_2 are in opposite phase for push-pull and e_3 is in phase quadrature. This last term is included so that the case when the input voltages to the two valves are not exactly in opposite phase can be considered; e_1 on the one hand and e_2 and e_3 on the other are respectively μ_1 and μ_2 times the actual input voltages E_1, E_2 and E_3.

First of all, e_3 will be taken as zero. It can be seen from the equations in the Appendix that both the fundamental and third-harmonic components are the same whether the valves are in parallel or in push-pull. With the latter circuit both the out-of-balance direct current in the output transformer and the second-harmonic distortion can be reduced to zero by the adjustment of the relative values of v_1, v_2, e_1 and e_2.

If the two valves are exactly alike the requirement for perfect balance is $v_1 = v_2$ and $e_1 = e_2$; that is, the two valves must have the same grid bias and their inputs must have the same amplitude, and be in opposite phase.

In this case the fundamental-frequency current in the H.T. lead is also zero. It is given by Equ. (4) by writing minus signs instead of + between the pairs of terms in brackets. Because of this a favourite way of balancing a push-pull amplifier is to insert a resistance shunted by a pair of 'phones in the H.T. lead, as shown dotted in Fig. 1, and to adjust the relative values of the input voltages E_1 and E_2 for zero fundamental tone in the 'phones.

Of course, in this particular case, since the output stage is assumed itself to be perfectly balanced, all that is done is to equalize E_1 and E_2 and so to correct for imperfections in the preceding stage.

Balancing Adjustment

When the valves are not identical, second-harmonic distortion in the output and the out-of-balance mean current can both be brought to zero by adjusting the values of e_1/e_2 and v_1/v_2. With no signal the out-of-balance current depends only on v_1/v_2, but the condition for zero second-harmonic distortion depends on both e_1/e_2 and v_1/v_2. The out-of-balance current with a signal depends also on both e_1/e_2 and v_1/v_2, so that the zero signal balance is not necessarily maintained when a signal is applied.

When $e_3=0$, Equ. (3) shows that the out-of-balance current can be brought to zero even when the valves are not alike by adjusting v_1/v_2 with no applied signal. Equ. (5) shows that the second harmonic in the output can also be brought to zero even although the valves are not alike by adjusting e_1/e_2. When this is done the signal-dependent terms in Equ. (3) are also zero, so that just as in the case of identical valves the second-harmonic and out-of-balance currents can be made zero for all amplitudes of input.

However, the fundamental-frequency component in the H.T. lead (Equ. (4) with − signs before each group of terms with subscripts 2) is no longer necessarily zero. This is also obvious on physical grounds, for if the valves are unlike they introduce different percentages of second harmonic. When adjusted for zero total second harmonic in the output each valve must be giving the same amplitude of second-harmonic output. But if the percentages are different the fundamental outputs must also be different, and so they cannot balance in the H.T. lead.

It is thus clear that in the general case the popular method of balancing an amplifier for zero fundamental component in the H.T. lead will not necessarily give zero second harmonic in the output. It will only do so, in fact, if the output valves are identical.

Strictly speaking, therefore, the right way of adjusting e_2/e_1 is directly for minimum second-harmonic distortion in the output. This is very inconvenient, however, for it demands the connection of a filter in the output to suppress the strong fundamental component.

It has been assumed so far that the input voltages to the two values are precisely in opposite phase; i.e., $e_3=0$. In practice, phase errors occur towards the two ends of the frequency range. They occur chiefly in the phase-splitting circuits. They can be represented by a voltage E_3 which is 90 deg out of phase with the input E_2 to one of the valves, E_2 itself being exactly in opposite phase to E_1.

Phase Unbalance

The effect of E_3 is to produce output currents in quadrature to those caused by E_1 and E_2, but through interaction between them it does also produce currents additive to the main ones. Because of the quadrature currents it becomes impossible to balance second-harmonic distortion to zero and equality of mean anode currents cannot be maintained at all signal levels.

However, these effects are very small in practice because it is not difficult to keep the phase errors small. It is by no means easy to make them zero but in a common type of phase-splitter they can be such that E_3 does not exceed about 3 per cent of E_2.

There are so many possible causes of unbalance in a push-pull stage that it might be thought that a balancing adjustment would be essential. This is not so, however, for a surprisingly large amount of unbalance can often be tolerated.

In general, balancing adjustments are undesirable if their use can be avoided, for their correct use demands some degree of skill. It is, therefore, the usual commercial practice to dispense with them. This is done by determining a permissible degree of unbalance which affects the performance negligibly, and then designing the equipment so that this degree of unbalance is not exceeded with any normal variations of components and valves.

Under such conditions neither the out-of-balance current nor the second-harmonic distortion will usually be zero, but this does not matter provided that the resulting distortion is small enough. An output stage might, for instance, be designed for 2 per cent third-harmonic distortion at full output. The second-harmonic distortion might vary from the ideal zero to, perhaps, 1 per cent according to the degree of balance achieved. The addition of 1 per cent second harmonic to a stage already giving 2 per cent third-harmonic distortion is not likely to be noticeable to the ear. The total distortion is increased to $100\sqrt{[0.02^2 + 0.01^2]} = 2.25$ per cent, little over 1db. Moreover, the ear is more tolerant of second- than of third-harmonic distortion. It is, therefore, almost certain that the extra distortion would not be aurally detectable.

However, this may be, it is certain that there is some degree of second-harmonic distortion relative to the third harmonic which cannot be detected in any listening test. Provided that the second harmonic can be kept below this figure, therefore, its presence is immaterial, and if an amplifier can be designed which is inherently well enough balanced to keep the distortion below this figure its performance is as good as one more perfectly balanced. It is also much more satisfactory in practice.

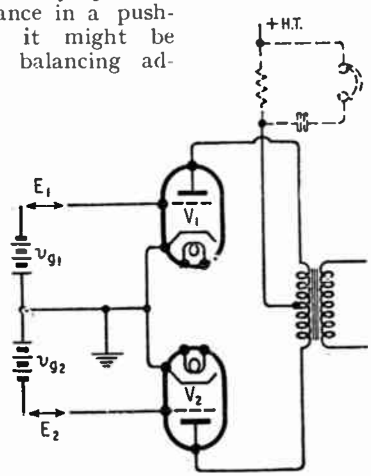

Fig. 1. The basic push-pull circuit. The dotted components in the H.T. lead are often inserted when balancing a stage

In order to determine how much unbalance is permissible in an amplifier it is necessary to know how much second-harmonic distortion can be allowed. This can only be settled by elaborate listening tests with large numbers of observers. For present purposes it will be assumed that an amount of second harmonic equal to the third harmonic is unimportant.

Push-pull Balance—

This is a 3-db increase in distortion from an "ideal" level of −34db, assuming that 2 per cent third harmonic is the target. The distortion level thus rises from the "ideal" −34db to −31db and this in itself would not be readily detected by ear. When the greater tolerance of the ear to second-harmonic distortion is taken into account, it seems certain that its presence in this degree is unimportant.

At present this must be largely a matter of opinion, and it is possible to work out the permissible unbalances for any desired ratio of 2nd/3rd harmonic distortion. In the following examples, however, a figure of unity for this ratio is taken as the maximum permissible.

For the present assume that there is no phase unbalance ($e_3=0$). Then Equ. (9) in the Appendix gives the ratio of 2nd/3rd harmonic distortion. The ratio does not depend only on the ratios e_2/e_1, v_2/v_1, c_2/c_1, d_2/d_1, but also on c_1/d_1, e_1 and v_1. It is not, therefore, possible to derive a general solution applicable to all valves, but it is necessary to work out the permissible unbalances for each case.

The best that can be done, therefore, is to pick a typical case and the following values will be assumed: $b_1=2\times10^{-4}$, $c_1=-3\times10^{-7}$, $d_1=1.25\times10^{-9}$, $e_1=120V$, $v_1=180V$. These values correspond to a fictitious valve having 300V H.T., −40V grid bias, $\mu=3$ and a signal input of 40V peak. A single valve, or a pair in parallel, produce 2 per cent third-harmonic distortion and 10 per cent second harmonic. It is required to determine how the second-harmonic distortion of a pair in push-pull varies with the various out-of-balance elements.

This is done by taking the above values for the valves and calculating the 2nd/3rd harmonic ratios with the aid of Equ. (9). The results are shown in Fig. 2; curve A shows how the harmonic ratio varies as e_2/e_1 varies for the case when the valves are identical and $v_1=v_2$. For unity distortion ratio over 20 per cent unbalance of the input voltages is permissible. Curve B shows the effect, with $e_2=e_1$, $d_2=d_1$ of varying c_2/c_1 and curve C illustrates the effect

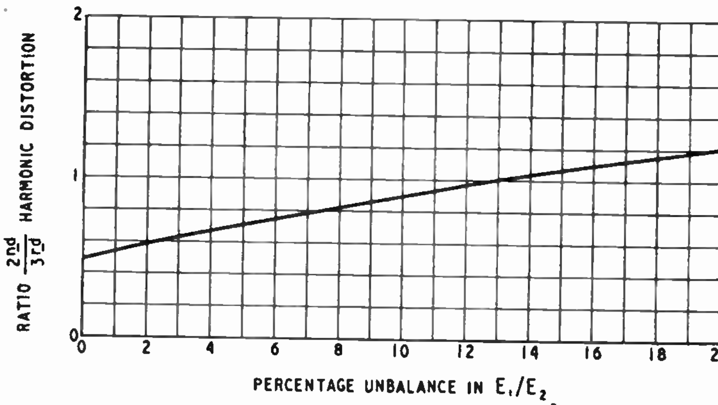

Fig. 3. The effect of varying e_2/e_1 is shown here for the case when $v_2/v_1=1$, $c_2/c_1=d_2/d_1=1.2$, and $e_3/e_2=0.03$.

of varying d_2/d_1 with $c_2=c_1$. Even with 20 per cent difference between either of these valve constants the second harmonic does not exceed 0.4 of the third.

The effect of varying v_2/v_1 is shown in curve D. This, however, is not a grid-bias variation but one of total voltage. It can be converted to one of grid-bias variation in this instance by multiplying the "Percentage Unbalance" scale in Fig. 1 by 1.5. By using equation (13) the effect of varying e_3/e_2 can be computed and is shown in curve E.

In a practical case these variations may all occur together but it is clear from Fig. 2 that in order of importance the various causes of unbalance are e_3/e_2, v_2/v_1, e_2/e_1, c_2/c_1, d_2/d_1. This is rather a fortunate order, for the valve variations are of least importance and it is these which are least under the control of the amplifier designer. It is well to allow a maximum variation here and it is not unreasonable to take $c_2/c_1=d_2/d_1=1.2$; that is, 20 per cent unbalance between valves.

If the valves are operated in the usual way with a common bias resistor $v_2/v_1=1$. The out-of-balance current in the output transformer rarely exceeds 10mA, in practice, and this causes negligible distortion when a well-designed transformer having a silicon-steel core is used.

The phase unbalance between

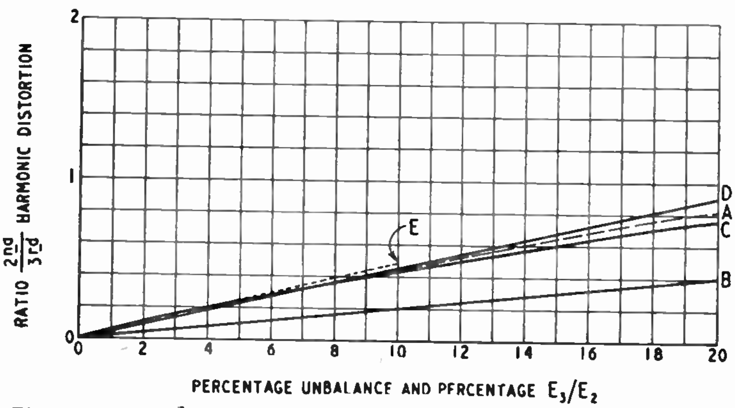

Fig. 2. The effect on the ratio of 2nd/3rd harmonic distortion of various kinds of balance is shown here.
Curve A $c_2/c_1=d_2/d_1=v_2/v_1=1$, $e_3=0$, e_2/e_1 varying.
B $e_2/e_1=d_2/d_1=v_2/v_1=1$, $e_3=0$, c_2/c_1 varying.
C $e_2/e_1=c_2/c_1=v_2/v_1=1$, $e_3=0$, d_2/d_1 varying.
D $e_2/e_1=c_2/c_1=d_2/d_1=1$, $e_3=0$, v_2/v_1 varying.
E $e_2/e_1=c_2/c_1=d_2/d_1=v_2/v_1=1$, e_3/e_2 varying.

the inputs is usually negligible over the major p--t of the audio-frequency spectrum. At very low and very high frequencies it becomes of appreciable magnitude but with good design it is not large. It occurs chiefly in the phase-splitter and may amount to about 3 per cent. The value of e_3/e_2 will, therefore, be taken as 0.03.

With these values as reasonable tolerances to allow for variations in values and for some phase unbalance the ratio of 2nd to 3rd harmonic distortion for various values of e_2/e_1 can now be calculated and the permissible input unbalance so determined.

The result is shown by the curve of Fig. 3 and it will be seen that for unity distortion ratio an input unbalance of as much as 13 per cent can be allowed. This is for the worst case when the input unbalance is in the same sense as the others; when it is opposing, a much bigger tolerance is permissible.

Grid-Current Effects

It will be clear from all this that a push-pull stage is very far from being critical and what at first appear to be quite large amounts of unbalance have quite a small effect on the performance. This is in accord with practical experience.

In the foregoing it has been assumed that there is no limit to the permissible value of E_1/E_2 (e_1/e_2) other than that set by the appearance of excessive second-harmonic distortion. This is not the case, in practice, however, for if the two input voltages are dissimilar then one valve will run into grid current earlier than the other unless the valve with the larger input has a proportionately higher grid bias. Very serious distortion usually occurs when grid current starts, and if one valve draws grid current before the other the amplifier is overloading before the other valve is giving its full output.

Conditions in this respect are likely to be at their worst when an amplifier is carefully balanced for zero second-harmonic and out-of-balance currents! The poorer valve of the two may need the greater input and the smaller grid bias for balance.

The tolerance permissible on E_1/E_2 is thus likely to be tighter for the avoidance of marked disparities in the grid-current overload points of the two valves than for avoidance of second-harmonic distortion. If the bias is 40V and the maximum input is 40V peak, then with the 13 per cent tolerance found earlier, the input to the other valve will be only 35.4V. As the power output is proportional to the square of the input voltages it will be about $(75.4/80)^2 = 0.89$ of that which would be obtained with equal input voltages and identical valves.

The loss is not large, but a somewhat tighter input tolerance would seem desirable. It is suggested that an input tolerance of ±5 per cent should be aimed at in designing the preceding stages and that there should be not more than 3 per cent phase unbalance at high and low frequencies. This permits rather greater tolerances on valves than have been considered in the foregoing.

No attempt at balancing second-harmonic distortion to zero should normally be made and it is only necessary to balance the mean anode currents in exceptional cases or when high-permeability core material is used in the output transformer.

APPENDIX.

Let the characteristics of valves 1 and 2 be expressed by

$$i_{a1} = a_1 + b_1V_1 + c_1V^2 + d_1V^3{}_1 \qquad \text{(1)}$$

$$i_{a2} = a_2 + b_2V_2 + c_2V^2{}_2 + d_2V_2{}^3 \qquad \text{(2)}$$

where $V_1 = V_{a1} + \mu_1V_{g1} + \mu_1E_1 \sin \omega t = v_1 + e_1 \sin \omega t$

$V_2 = V_{a2} + \mu_2V_{g2} - \mu_2E_2 \sin \omega t - \mu_2E_3 \cos \omega t = v_2 - e_2 \sin \omega t - e_3 \cos \omega t$

When the values are combined in push-pull the effective current is $i_{a1} - i_{a2}$ whereas when they are in parallel it is $i_{a1} + i_{a2}$ and $V_2 = v_2 + e_2 \sin \omega t$. Inserting the values of V_1 and V_2 in (1) and (2) and expanding, we get :—

Out-of-balance D.C. component $= I_{DC} =$

$$(a_1-a_2)+(b_1v_1-b_2v_2)+(c_1v_1^2-c_2v_2^2)+(d_1v_1^3-d_2v_2^3) + \tfrac{1}{2}(c_1e_1^2-c_2e_2^2)+\tfrac{3}{2}(d_1e_1^2v_1-d_2e_2^2v_2)-\tfrac{1}{2}c_2e_3^2-\tfrac{3}{2}e_3^2v_2d_2 \qquad \text{(3)}$$

Fundamental frequency component $= I_1 =$

$$\sin \omega t[(b_1e_1+b_2e_2)+2(c_1e_1v_1+c_2e_2v_2)+3(d_1e_1v_1^2+d_2e_2v_2^2) + \tfrac{3}{4}(d_1e_1^3+d_2e_2^3)+\tfrac{3}{4}e_3^2e_2d_2] + \cos \omega t[b_2e_3+2c_2e_3v_2+3e_3v_2^2d_2+\tfrac{3}{4}d_2e_2^2e_3+\tfrac{3}{4}d_2e_3^3] \qquad \text{(4)}$$

Second-harmonic component $= I_2 =$

$$-\cos 2\omega t[\tfrac{1}{2}(c_1e_1^2-c_2e_2^2)+\tfrac{3}{2}(d_1e_1^2v_1-d_2e_2^2v_2)+\tfrac{1}{2}c_2e_3^2+\tfrac{3}{2}d_2e_3^2v_2] + \sin 2\omega t[-c_2e_2e_3-3d_2e_2e_3v_2+\tfrac{3}{2}d_2e_2e_3^2] \qquad \text{(5)}$$

Third-harmonic component $= I_3 =$

$$-\sin 3\omega t[\tfrac{1}{4}(d_1e_1^3+d_2e_2^3)] + \cos 3\omega t[\tfrac{1}{4}d_2e_3^3+\tfrac{3}{4}d_2e_2^2e_3+\tfrac{3}{4}d_2e_2e_3^2] \qquad \text{(6)}$$

When $e_3 = 0$, for two values in parallel or push-pull, the fractional third harmonic distortion is

$$\frac{\tfrac{1}{4}(d_1e_1^3+d_2e_2^3)}{(b_1e_1+b_2e_2)+2(c_1e_1v_1+c_2e_2v_2)+3(d_1e_1v_1^2+d_2e_2v_2^2)+\tfrac{3}{4}(d_1e_1^3+d_2e_2^3)} \qquad \text{(7)}$$

When $e_3 = 0$, the fractional second harmonic is (+ signs for two valves in parallel, − signs for push-pull)

$$\frac{\tfrac{1}{2}[(c_1e_1^2 \pm c_2e_2^2)+3(d_1e_1^2v_1 \pm d_2e_2^2v_2)]}{(b_1e_1+b_2e_2)+2(c_1e_1v_1+c_2e_2v_2)+3(d_1e_1v_1^2+d_2e_2v_2^2)+\tfrac{3}{4}(d_1e_1^3+d_2e_2^3)} \qquad \text{(8)}$$

Therefore, the ratio of 2nd/3rd harmonic distortion is

$$2\frac{c_1}{d_1e_1} \cdot \frac{\left(1 \pm \frac{c_2}{c_1} \cdot \frac{e_2^2}{e_1^2}\right) + 3\frac{d_1v_1}{c_1}\left(1 \pm \frac{d_2}{d_1} \cdot \frac{e_2^2}{e_1^2} \cdot \frac{v_2}{v_1}\right)}{1 + \frac{d_2}{d_1} \cdot \frac{e_2^3}{e_1^3}} \qquad \text{(9)}$$

For zero second harmonic distortion the requirement is

$$\left(\frac{e_1}{e_2}\right)^2 = \frac{c_2+3d_2v_2}{c_1+3d_1v_1} \qquad \text{(10)}$$

For zero out of balance current it is necessary to have :—

$$a_1-a_2+b_1v_1-b_2v_2+c_1v_1^2-c_2v_2^2+d_1v_1^3-d_2v_2^3 + \tfrac{1}{2}(c_1e_1^2-c_2e_2^2)+\tfrac{3}{2}(d_1e_1^2v_1-d_2e_2^2v_2) = 0 \qquad \text{(11)}$$

This can be zero for any values of e_1 and e_2 only if the last two brackets are themselves zero. This is the case when Equ. (10) is met.

Crystal Pickups

Basis of Design for High-fidelity Reproduction

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IT is not realized as widely as it should be that the piezo-electric crystal pickup operates on a principle fundamentally different from that underlying the moving coil, or other electro-magnetic types of pickup, and that attempts to treat it on the same footing are foredoomed to failure. It is the purpose of this article to discuss this difference, and to show that, combined with suitable electrical networks, the crystal pickup can give results at least as good as those obtainable from the electro-magnetic types, together with the advantages of high sensitivity, and the possibility of dispensing with coupling transformers, hum pick-up and other troubles.

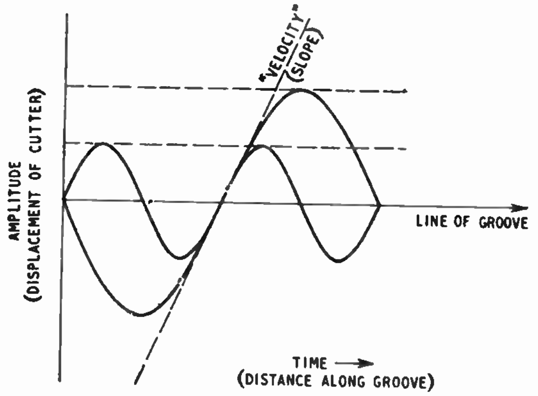

Fig. 1. Illustrating the relationship between "velocity," amplitude and frequency.

Commercial recordings are generally made with electro-magnetic cutting heads. It is a characteristic of this type of head that constant input to the recording amplifier (here assumed to be linear), does not produce constant amplitude of vibration, but constant "velocity" of the stylus point. This velocity is the rate of change of displacement as the cutter passes through its mid position in each half cycle, and is represented by the slope of the sine wave at this point. It can be shown mathematically, or seen by inspection of Fig. 1, that to keep the velocity (i.e., slope) constant, the amplitude must increase as the frequency is decreased and vice-versa. In the example shown, the two sine waves have the same velocity, but it will be seen that there is a 2 : 1 ratio of amplitude and a 1 : 2 ratio of frequency. It is clear that for adequate amplitude at the higher frequency end of the spectrum, the amplitude at the lower frequency end would become excessive, with the possibility of break-through into adjacent grooves. Because of this it is commercial practice to modify the amplifier and produce a constant-amplitude cut below a certain frequency (the turn-over or cross-over frequency).

Every commercial record is therefore a mixture of constant-amplitude and constant-velocity cutting, and the shape of the recording characteristic is entirely a matter of one's point of view; i.e., whether one chooses to put amplitude or velocity on the vertical scale. This is illustrated in Fig. 2; it will be noted that the turn-over frequency is at 250 c/s, in accordance with general practice in this country, though turn-over frequencies of the order of 300, 500, 800 and 1,000 c/s are used commercially and by amateurs.

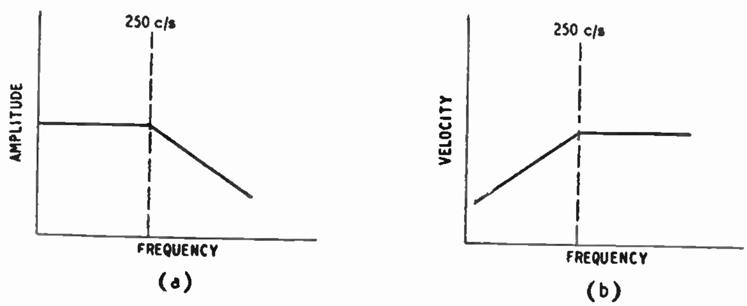

Fig. 2. The average recording characteristic of commercial discs is level below 250 c/s for amplitude-operated pickups, (a) and above 250 c/s for velocity-operated types, (b).

A piezo-electric crystal is one which, when strained, produces electric charges on certain of its faces, the magnitude of these charges being directly proportional to the strain. This over-simplified picture gives a clue to the behaviour of the crystal pick-up. In actual practice, two slabs of a piezo-electric salt (usually sodium potassium tartrate, otherwise known as Rochelle Salt) are cemented together with one electrode between the slabs, and another in contact with both outer faces. The slabs are cut in such a manner that a torque (in the case of a "twister" crystal) or a flexure (in the case of a "bender" crystal) will produce a potential difference across the electrodes. This assembly is known as a bimorph, the torsional (or "twister") variety being used in most crystal pickups. Clearly, therefore, the output from a crystal pickup is directly proportional

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to the amplitude and not the velocity of the stylus displace-

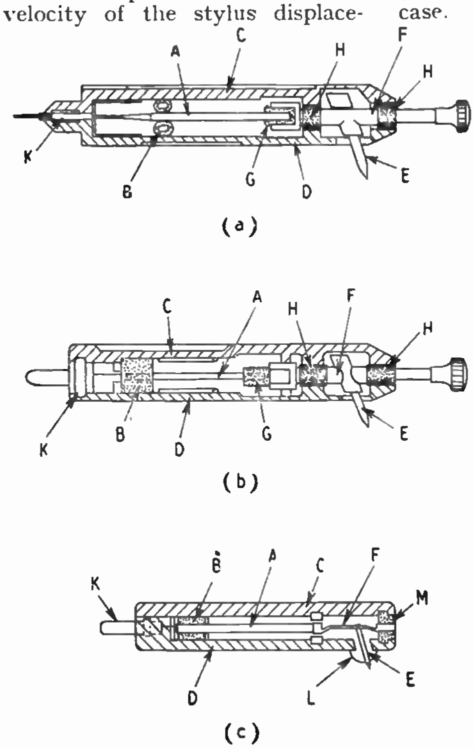

Fig. 3. Constructional details of some piezo crystal pickup types.

ment. In this fact lies the difference between crystal and electro-magnetic pickups, since the output of the latter is directly proportional to the velocity of the stylus displacement. In the region below 250 c/s. where these pickups require correction, the crystal pickup gives constant voltage output, but it in turn requires correction above 250 c/s. It is of interest to note that, if considered in octaves, this point lies only one octave below the middle of the recorded spectrum.

The practical constructions of three types of crystal pickups are shown in Fig. 3. Fig. 3 (a) is the simplest form of crystal pickup using a "twister" crystal. The crystal (A) is clamped at the rear by two pieces of P.V.C. tubing (B), which are cemented to the upper and lower halves of the case (C) and (D). Movement of the needle (E) is applied by the reed (F), the crystal being protected from the hard metal surface of the fork in the reed by a wrap of rubber (G). The reed moves in the rubber sleeves or bearings (H) which are clamped in the case. The electrodes from the crystal are brought out and soldered to a terminal board (K), which itself is clamped in the case.

A more modern version of this assembly is shown in Fig. 3 (b). The back mounting of P.V.C. has been replaced by a moulded rubber block (B) specially shaped to touch the case only at its four corners. The wrap of rubber has been replaced by a moulded rubber transmission member (G) which, whilst transmitting needle vibrations, will absorb undue shocks. This type of construction is extremely robust, the crystal being virtually unbreakable.

In a high-fidelity unit the mass of the moving parts must be kept as small as possible. One method of achieving this is by making the assembly as shown in Fig. 3 (c). The conventional reed, needle screw and removable stylus have been replaced by a thin beryllium copper transmission strip (F) into which is welded a thin-walled metal tube (E) carrying a ground and highly polished sapphire tip, the front end of the transmission member being supported by a moulded rubber block (M). Some degree of protection for the stylus is supplied by the two blisters (L) moulded in the lower half (D) of the case. The rest of the assembly will be obvious from the drawing.

It may be of interest to note the relative masses of the moving parts in the assemblies as shown in Figs 3 (a) and 3 (c). The mass of the needle, reed and needle screw used in the former totals 1.22 gm whereas the combined mass of the equivalent parts of the latter is 0.186 gm.

Ideally, the frequency charac-

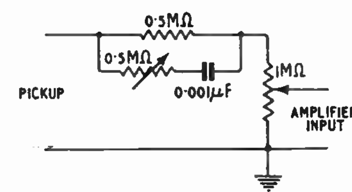

Fig. 5. Simple stop-lift correction circuit for use with general-purpose type crystal pickup.

teristic of a crystal pickup when measured on a commercial record would be as Fig. 2 (a). This ideal is approached very closely in some of the modern high fidelity crystal instruments (e.g., Brush PL 50 and Acos GP-12). A response curve of the latter instrument is shown in Fig. 4: plotted on the same ordinates are the characteristics, on an amplitude basis, of the test records (H.M.V DB 4034/7), and also of a general-purpose unit crystal pickup. The vibratory system (i.e., needle, needle screw and reed) resonates between 5,000 and 6,000 c/s.,

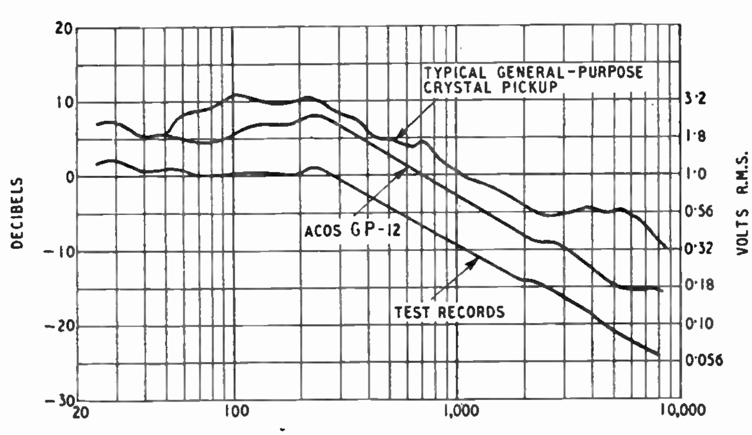

Fig. 4. Comparison of general-purpose and high-fidelity crystal pickup characteristics.

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thus accounting for the levelling out of the response curve from 2,500 c/s. upwards, and the rapid drop through the region 7,000 8,500 c/s. The small peak at 700 c/s. is due to a torsional arm resonance and being of the order of 2 db it can be safely ignored. After the levelling out which is to be expected at 250 c/s., the output tends to fall off at 100 c/s, but is maintained by the flexural arm resonance down to 60 c/s below which it drops rapidly. A point which should be noted about these crystal pickups is the very high output: at 1,000 c/s it is 0.7 volt for the high-fidelity unit, and 1.0 volt for the general-purpose unit; at 250 c/s it is 2.5 volts and 3.2 volts respectively.

These response curves show that to obtain faithful reproduction there is a need for a levelling of the output to produce a linear input to the amplifier grid.

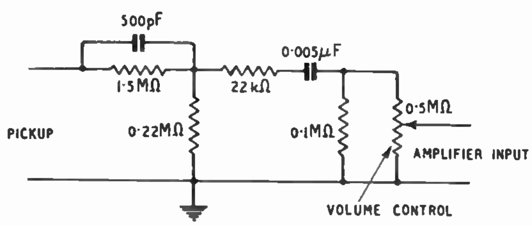


Fig. 6. Circuit giving full equalization with Acos GP-12 high-fidelity pickup.

The general purpose instrument is often used without any correction at all, since the fall in top will appear to reduce needle scratch, and will minimise the unpleasantness of the "pentode top" so often associated with the less expensive and older radio receivers. Should some degree of top correction be required, the simple circuit shown in Fig. 5 will be found to be completely satisfactory.

For those requiring an extremely high standard of reproduction, the high-fidelity instrument (Acos GP-12) with full equalization will be chosen. Though simple, equalization should be a matter of some care: tuned circuits and iron-cored components should obviously be avoided. The simple circuit shown in Fig. 6 is recommended, and a response curve of the high-fidelity pickup using this equalizer is shown in Fig. 7. It will be seen from this that the overall output level has dropped to 0.1 volt, which is, of course, what would be expected.

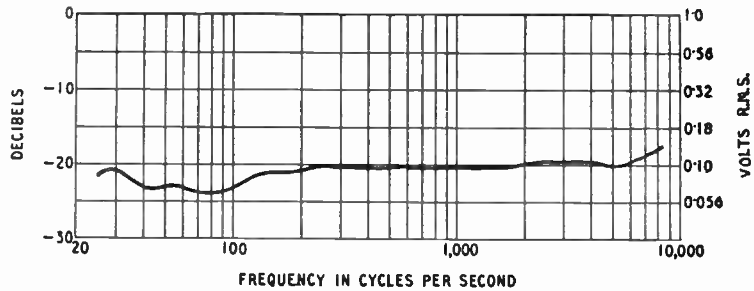


Fig. 7. Frequency response of high-fidelity pickup in conjunction with circuit of Fig. 6.

It is often stated that the overriding disadvantage of crystal pickups is that they introduce severe harmonic distortion. The authors have taken many cathode-ray oscilloscope observations over a wide frequency range, and have come to the conclusion that with a well-designed (though not necessarily expensive) crystal pickup, the waveform distortion is negligible, being well under the limit of 2% accepted by the industry for high-fidelity apparatus. Much harmonic distortion is often introduced in the first amplifier stage, where the high output from the pickup overloads the input valve. This trouble will not be encountered if the input circuits (Figs. 5 and 6) recommended above are used.

Tone arm designed for Acos GP-12 pickup.

The piezo-electric crystal is inherently capable of the highest fidelity of reproduction, and when housed in pickup cartridges of modern lightweight design will prove by its performance that it is worthy of the serious consideration of quality enthusiasts.

BOOKS RECEIVED

Practical Mechanics for All.—Edited by Leroy A. Beaufoy, M.Sc., Ph.D. The fourteen chapters of this book, written by eight authors, cover all the aspects of mechanics from the fundamental theories of the lever and pulley to their applications in the testing and driving of machines. 448 pages, with nearly 500 diagrams. Odhams Press, Ltd., Long Acre, London, W.C.2. Price 9s 6d.

Two-Way Radio.—By Samuel Freedman. The growing interest in the applications of two-way radio, especially in the field of citizens' radio, has prompted the publication in the United States of this volume, which deals with the design, organization and application of two-way radio. 506 pages+xxii pages. Ziff, Davis, Ltd., The Grampians Building, Western Gate, London, W.6. Price 30s.

Radio-Craft Library.—We have recently received ten of the booklets in this series, which is prepared by the Editors of *Radio-Craft*. Most of the material has been culled from the pages of our New York contemporary. Each booklet contains 64 pages, has numerous diagrams, and costs 50 cents. The titles are: Handy Kinks and Short Cuts, No. 29; Unusual Patented Circuits, 1944-1946, No. 30; Radio Questions and Answers, No. 31; Advanced Service Technique, No. 32; Amplifier Builder's Guide, No. 33; Radio-Electronic Circuits, No. 34; Amateur Radio Builder's Guide, No. 35; Radio Test Instruments, No. 36; Elementary Radio Servicing, No. 37; How to Build Radio Receivers, No. 38.; Radcraft Publications, Inc., 25, West Broadway, New York, 7, U.S.A.

High Audio Frequencies

Are They Necessary : Are They Nice?

Results and conclusions of some recent experiments and discussions on the role of high frequencies in the production of acceptable sound quality are summarized for the benefit of high fidelity enthusiasts who may not have access to the literature.

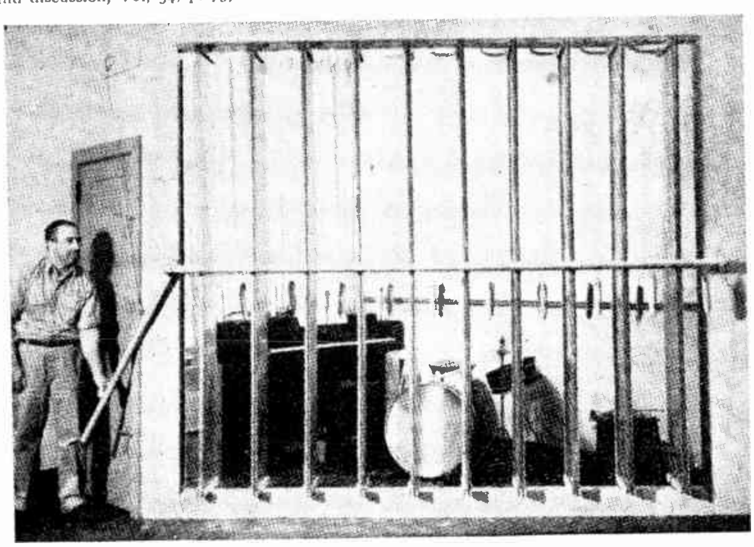
IN America a series of tests of listeners' preferences[1] have been made with the help of 500 listeners from all walks of life, using a reproducing system in which "every possible precaution was taken to ensure as near perfect reproduction as it was possible to achieve." Programme material included male and female speech, popular and classical music, and the tests were made through filters restricting the frequency range to 150 – 4,000 c/s (narrow), 70 – 7,000 c/s (medium) and 40 – 10,000 c/s (wide). Results were analysed and the conclusions drawn that listeners preferred either a narrow or medium tonal range to a wide one, even when informed that one condition was "low fidelity" and the other "high fidelity," that listeners preferred a slightly wider band for female speech, piano, and popular orchestra selections than for male speech, mixed dramatic speech, and classical orchestra selections, and that two groups with special experience, professional musicians and frequency-modulation listeners, indicated substantially the same preferences as did the average cross-section of listeners.

These conclusions did not go unchallenged. E. Massell pointed out that the question of distortion had been dismissed with the statement that trained observers failed to detect distortion. Since the ear accommodates itself, it would seem that the more "trained" an observer, the less qualified he would be to detect distortion. If distortion, particularly that resulting from cross-modulation with creation of new discordant frequencies, were present, it would be most evident in the higher frequencies, and hence would be cut out by the narrower reproduction. This, he contended, was borne out by the correlation of preference for narrow range with the complexity of the original sound; i.e., the classical orchestra (40 pieces) was most definitely preferred at "low fidelity," whereas wide range was preferred over medium range in the piano, popular orchestra (29 pieces), and female speech selections.

W. van B. Roberts said he believed the statements should have been made along the lines that: "Listeners to *our reproducing system prefer* . . ." This, he said, might appear a trifling criticism because it was obviously the case, but since the paper laid some stress on the purely scientific nature of the investigation reported, it would seem well to be careful not to give the impression of enlarging the conclusions beyond what was actually proved. For example, if the reproducing system used in the experiments had been sufficiently bad, the conclusion might have been that listeners preferred total silence, a conclusion that surely would require qualification. Roberts went on to say that he saw no *a priori* reason to agree that a few tenths of one per cent distortion is necessarily negligible, any more than that a similarly small percentage of essence of skunk would be a negligible matter in a flower garden.

It was suggested, also by Roberts, that an instructive modification of the test would be to engage a good orchestra with first-quality instruments, and put them on a platform behind a light screen, or have the audience blindfolded. The audience would then alternately hear the actual orchestra and recordings thereof. If the audience preferred the real thing to a reproduction, but preferred narrow-gauge reproduction to wide-range, the conclusion would be that the human ear objects to distortions in the high-frequency range that are too small to be measured by instruments. In this

[1] "Tonal Range and Sound Intensity Preferences of Broadcast Listeners." H. A. Chinn and P. Eisenberg, *Proc. I.R.E.*, Vol. 33, p. 571 and discussion, Vol. 34, p. 757.



Acoustical filter screen used in direct listening tests organised by Dr. H. F. Olson.

High Audio Frequencies—

case the goal of the engineer would still be merely (!) exact reproduction. But it was quite conceivable that the audience would prefer narrow-range reproduction to the real thing, and if this should be the case a disturbingly wide new field would be opened to the profession. Future radios and gramophones might be advertised with a real basis of fact to have "new tone quality." Symphony orchestras might perform behind sound-proof glass on "dime-store" instruments, the sounds being delivered to the audience through the new reproducing (?) systems as super-Stradivarii tones—or better.

In their reply the authors of the original paper pointed out that this test might show a preference for binaural or for monaural reproduction—not necessarily for tonal range. Single-channel or monaural listening imposes limitations and it is essential to work within these limitations. Thus if radio producers wished to imitate sound effects as they occurred in life, they often had to invent new apparatus or devices to obtain the effect, rather than use the original. It was not necessarily proposed that this should be done with all sound transmitted over radio; but, æsthetically, the characteristics of radio must be known so that the sound most pleasant to listeners could be produced. The authors did not see why it should be assumed that the original sound was the most beautiful, when it was known that certain instruments, like the trombone, were marred by excessive noise, and certainly many human voices could stand improvement. As Hollywood producers well knew, it was possible to improve on nature.

Here, in your reporter's humble opinion, we enter the province of the artist rather than the engineer, but it is important to know where we are heading and if possible to avoid chasing chimera. It can be shown[2] that in the evolution of some musical instruments, e.g., the violin and the oboe, the trend has been to reduce the energy content of the upper end of the spectrum, and from this it is easy to argue that there is something intrinsically distasteful to the human ear in high-pitched sounds.

This is a tempting hypothesis—particularly to those who have laboured to give us high-frequency response in receivers, amplifiers and loudspeakers only to find that we throw all their good work away with a generous twist of the top-cut tone control knob. But can we make scapegoats of our own ears? The sounds of nature and the noises of urban life, whether we like it or not, are as full of high as of medium and low frequencies. If music is to be capable of matching this range of emotionally significant sounds it should, and in fact does, have at its command instruments with astringent as well as suave tone. By all means let the violins be smoother than any singing voice, but at the same time let the biting edge of the brass tone be harsher if possible than any circular saw.

It seems probable that listeners revolt not against high frequencies themselves but against something which is introduced as the result of electrical reproduction. Evidence in support of this is forthcoming from another series of *direct* acoustic tests devised and carried out by H. F. Olson.[3] In these, over a thousand listeners of all ages and vocations were invited to listen to a small orchestra, first directly and then through an acoustic filter screen cutting off all frequencies above 5,000 c/s. The results, reported at a meeting of the Acoustical Society of America on May 9th this year, showed that 59 per cent in the age group 14-20 and 75 per cent of listeners between the ages of 30 and 40 preferred the full frequency range. It was thought that listeners in the younger age group were to some extent conditioned by listening to cheap radio sets and gramophones rather than orchestras. Tests on speech also revealed a preference for full frequency range, and this result was the same whether or not the speaker's voice was already known to the listener.

This looks pretty conclusive, and if we accept the probability that monaural or binaural (single-channel or two-channel) reproduction has no bearing on the choice of bandwidth, but only on the appreciation of the spaciousness of the sound source, then it seems that we must agree that "... the true measure of the quality of an electro-acoustical system is the maximum bandwidth which the public finds acceptable."[4]

In this admirable inversion of the role of experimenter and guinea pig lies the best hope of improvement. There does not seem to be much wrong with the public's taste; there may be something obscurely wrong with some so-called high-fidelity reproducing systems. F.L.D.

[2] "Perfect *v.* Pleasing Reproduction." *Electronic Engineering*, January, 1947.

[3] "Listening Tastes Tested." *Radio Age*, July, 1947.

[4] "Psycho-Acoustical Aspects of Listener Preference Tests." C. J. Le Bel. *Audio Engineering, August*, 1947.

"Q" COIL PACK

THIS is a three-band coil unit around which a superheterodyne receiver using a 6K8G frequency changer valve (without an R.F. stage) can be built. Coils wound on low-loss plastic formers with adjustable dust-iron cores are fitted.

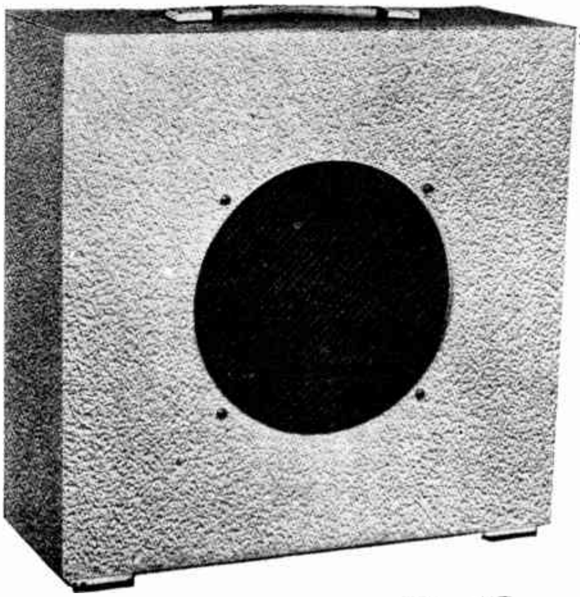
A feature of the coil pack is its small size, for it measures only 3½in × 2⅛in × 2in, yet it contains six coils, four pre-set trimmers, three fixed capacitors, and a wafer-type waveband switch.

Three-band "Q" coil unit for building a superheterodyne receiver.

There are three models available covering respectively the following wavebands: short, medium and long; two short and one medium; trawler, medium and long.

Supplied with each coil pack are diagrams for a five-valve superhet.

These units are made by Morgan Osborne & Co., Ltd., Southview Road, Warlingham, Surrey, and the price is 33s.



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For this recording and play-back Amplifier we claim an overall distortion of only 0.01% as measured on a distortion factor meter at middle frequencies for a 10-watt output. The output transformer can be switched from 15 ohms to 2,000 ohms, for recording purposes, the measured damping factor being 40 times in each case. Full details upon request.

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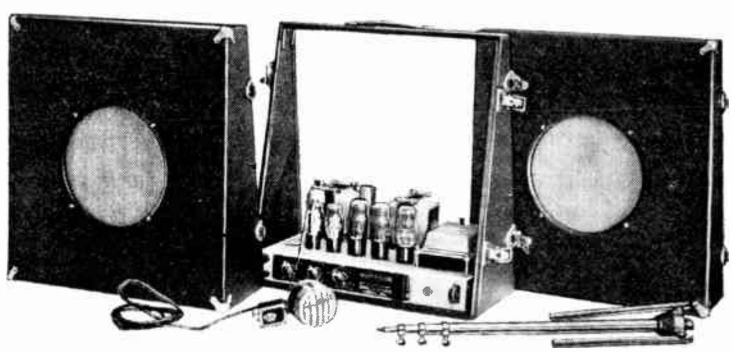
This 15-watt amplifier, has a response 35-25,000 cps. mixing arranged for pick-up and microphone, large output transformer for 4-7.5 and 15 ohms. Complete in 3-part leatherette case as illustrated, with two 10 in. P.M. Speakers, moving coil microphone and collapsible floor stand. Price 40 Gns.



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New Radio Compasses

Exhibits at the Aircraft Show

THE principal firms making radio equipment for use in aircraft showed some of their latest designs at the eighth flying display and exhibition held in September at Radlett aerodrome. Of special interest were the radio compasses shown by G.E.C. on Salford Electrical Instruments' stand and by Marconi's Wireless Telegraph Company.

The radio compass can be described as an automatic direction finder because once tuned in to a station it indicates every change in the bearing of that station in relation to the heading of the aircraft. It achieves this by a servo control system which automatically rotates the loop aerial to find the null signal position.

Simple though this may sound, its translation into a practical system is by no means easy, especially when everything has to be made as small and as light as possible for fitting in an aircraft and to function reliably over a very wide range of temperatures.

In the G.E.C. installation the signal picked up by the loop is passed to a cathode follower located in, or close to, the loop housing. From this unit a low-impedance cable takes the signal to the main receiver, generally accommodated in the radio cabin. Any length of cable can be used with negligible loss in signal strength.

After a stage of amplification the loop signal is passed to a balanced modulator, consisting of a pair of triodes, switched alternately from cut-off to the conducting state by a 100-c/s voltage derived from a winding on the small rotary transformer supplying the receiver H.T. voltage.

The output from the two valves is fed in push-pull to a transformer and there mixed with the same signal picked up on a short vertical aerial. Mixing of those two signals provides the required "sense" quality and is the usual practice.

After amplification and rectification in the main receiver, which is a sensitive superheterodyne, the 100-c/s modulation is fed through a low-pass filter (to improve the signal-to-noise ratio) into a two-stage servo amplifier. The output from this amplifier, at about 4 watts, is then fed into a 3-limb transformer which might be called the brain of the equipment.

To the transformer is applied also some of the original 100-c/s voltage derived from the generator and by suitable disposition of the windings the voltage induced in two of the secondary coils increases in one and decreases in the other, or vice versa, according to the phase relationship between the modulated signal voltage and the direct supply.

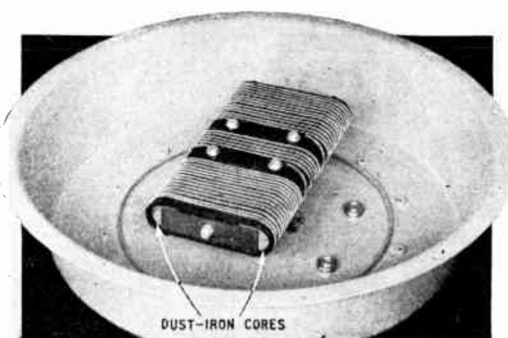
The output from each of these two secondaries is rectified and used to drive two small D.C. motors revolving in opposite directions and driving the loop through reduction gears and a differential mechanism.

When the input to the motors is the same the loop remains stationary, but any change in the individual supply voltages causes the loop to rotate one way or the other. The two voltages balance when there is no modulated signal fed to the transformer, a condition obtained when the loop is in the null signal position.

Rotation of the loop is transmitted by the Desynn electrical repeating system, used for the remote operation of a number of the aircraft instruments, to compass-type indicators located where needed in the aircraft.

Tuning and waveband changing is effected by electrical remote

The various units comprising the G.E.C. radio compass Two kinds of remote reading indicators are shown, also a duplicate control unit. The receiver is on the right.



Iron-cored loop aerial of the G.E.C. radio compass. The housing (partly removed in the photo) of this type is designed for internal mounting in the aircraft.

New Radio Compasses—

control and the dial readings are repeated back to the control unit by Desynn methods. Here the scale is magnified optically and projected on to a ground-glass screen.

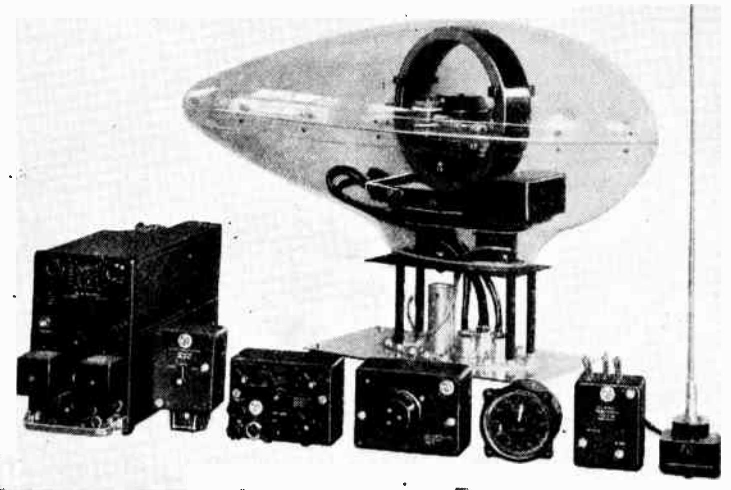
If required, the automatic facilities can be dispensed with and position finding carried out by the older method of aural determination of signal null and manual control of the loop motors.

This equipment covers 150 kc/s to 1,500 kc/s in three bands and makes use of a very compact type of loop fitted with iron-dust cores. Compensation is made for quadrantal error and a variable contour cam track is used to correct for irregularities in the Desynn potentiometer and driving mechanism.

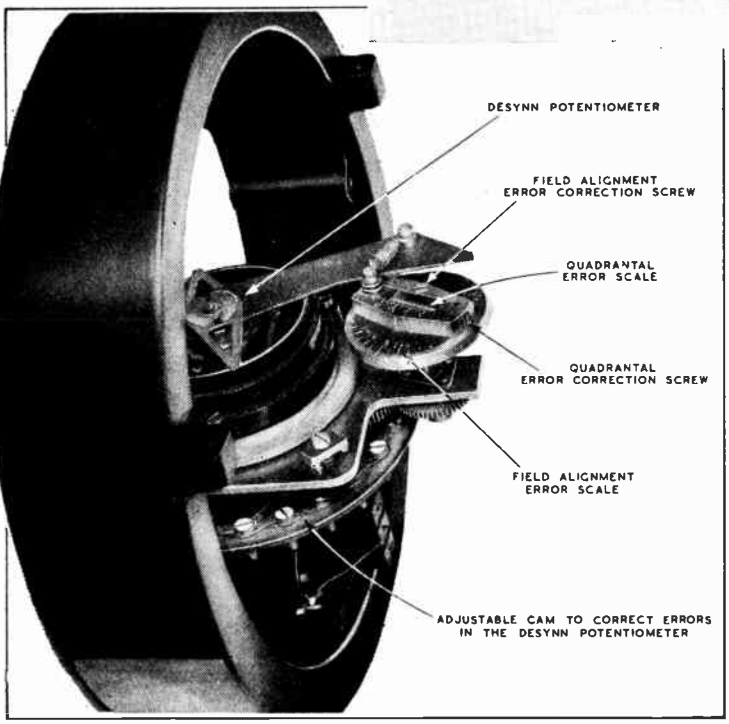
The Marconi automatic direction finder, Type AD7092, also functions on the principle of modulating the signal received on a loop by a low-frequency oscillation, mixing with it the same signal received on a short vertical aerial and, after amplification and rectification, comparing the phase of this composite signal with that of the original low-frequency oscillation and utilizing the error to control a servo system for rotating the loop.

Although basically the same, there are many differences in the way the results are obtained in these two radio compasses. In the Marconi set the low-frequency oscillation, which acts as the triggering or modulating signal, is derived from a vibrator, whereas in the G.E.C. equipment this is obtained from an additional winding on the rotary transformer.

After amplification the loop signal is applied to a balanced modulator triggered by the 110-c/s voltage supplied by the vibratory converter. The signal from the vertical aerial is mixed in the output circuit of the balanced modulator. Further amplification is carried out by a



Component parts for typical installation of the Marconi automatic direction finder. Left to right: receiver; voice-range filter; receiver remote control unit; loop controller; bearing indicator, which incorporates also tuning indicator; aerial matching unit and whip aerial. At the rear is the loop mounted in a "Perspex" streamlined housing.



Details of the loop assembly of the Marconi automatic direction finder. In centre, Desynn potentiometer, with, to the right, adjustment devices for correcting quadrantal and field alignment errors.

sensitive superheterodyne receiver tunable over the range 150 kc/s to 2 Mc/s.

After rectification the modulated component of the signal passes into a 110-kc/s amplifier and the output is then fed to one winding of a two-phase squirrel-cage motor, which drives the loop through a reduction gear. The other phase is obtained direct from the 110-c/s vibratory converter. The speed and direction of rotation of the motor depends on the phase relationship and relative magnitude of these two voltages and when the loop reaches its null position and there is no signal input the motor stops.

The position of the loop is transmitted electrically by the Desynn repeat-back system to compass-type indicating instruments located where required in the aircraft.

Provision is made for hand-operation of the loop by electrical remote control so that radio bearings can be taken in the orthodox fashion by aural indication of the null signal position.

Electrical and mechanical errors in the Desynn repeating system are corrected by using cam-operated mechanism for the potential divider in the loop assembly. The contour of the cam ramp is varied at regular intervals round the circumference so as to speed up or retard the movement of the rotor in relation to the loop spindle. Quadrantal error is also compensated for by an adjustable eccentric link in the loop rotating mechanism. Combined with it is a correction for field alignment error.

Miniature components are used throughout this equipment and the receiver is designed for fitting into the accepted standard type of aircraft signal racking. The main controls for the receiver are embodied in a small remote-control unit, the tuning and other operational adjustments being effected by a combination of electrical and mechanical connections. The receiver can also be used for the reception of C.W. and R.T. signals using either the loop or the vertical whip aerial.

Apart from these two radio compasses there was very little new equipment to be seen. Ultra had a very versatile intercommunication system for large aircraft providing facilities for remote control of centralized transmitters and receivers.

Standard Telephones were showing some new general-purpose transmitters and receivers designed on the small individual unit principle. The latest practice is to fit separate transmitters and receivers for the medium and the H.F. bands so that the aircraft installation can be built up according to the services required. Comprehensive remote control units are included in the installations.

G.E.C. showed an extremely compact V.H.F. radio-telephone aircraft and operating on one spot frequency in the range of 118.1 to 131.9 Mc/s. It has a range of about 30 miles at 1,000 feet and is an outstanding example of miniaturization.

Facsimile

A Review of the Position in America

FROM the frequent glowing reports in journals on both sides of the Atlantic of the progress of facsimile transmission in the U.S.A. it may have been concluded that it is an established service. This is certainly not borne out in an article in the June issue of our American contemporary *F.M. and Television*.

Technically, facsimile is ready to start as a commercial service for use in the home and industry, but the lack of standards for transmission is apparently holding things up.

So far as equipment is concerned a complete scanning installation for use with a standard F.M. transmitter is available for less than $4,500. At the receiving end miniature recorders for reproducing a single column news reel 4.1in wide are available at $100. The necessary amplifier for linking the recorder to a standard F.M. broadcast receiver costs $50. Recorders for use in club rooms, etc., which give an optical enlargement four times the normal width are also available.

The question is, why, with this equipment available, hasn't facsimile caught on in the States?

So far, agreement has been reached on the rate of scanning—105 lines per inch—and the speed at which the paper is issued from the recorder—3.43in per minute.

The controlling factor in establishing other standards is stated by the author to be paper width (or, more precisely, column width). Discussions have been centred around 4.1in and 8.2in. The relation of paper width to cost cannot be ignored. Whilst a recorder for the narrower paper costs about $100, one for the wider news reel is priced at $685!

The author points out that there is a definite relationship between paper width and frequency band-width. The keying frequency for 4.1in transmission, with the agreed rate of scanning and speed of paper feed, is 1,500 c/s. For black-and-white reproduction a sub-carrier frequency of 1.5 × 1,500 c/s (2,250) is adequate. This requires an A.F. band width of from 750 to 3,750 c/s. To transmit the tone shades of photographs, a sub-carrier of 2.3 × 1,500 c/s, or an A.F. band of from 2,000 to 5,000 c/s, is required. These figures must be doubled if the column width is increased to 8.2in.

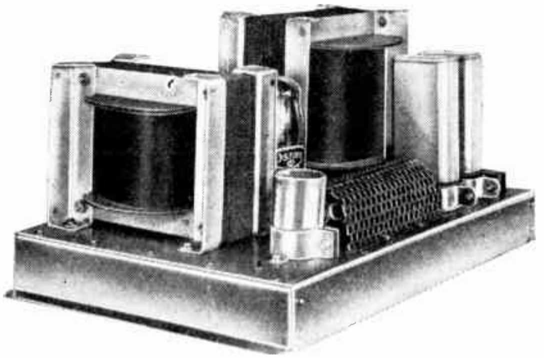
It will be seen, therefore, that paper width will affect F.M. receiver design. For, while an average F.M. receiver will meet the requirements for the narrower paper width, it will require a first-class set if the band-width is increased to 4,000-10,000 c/s. The more expensive facsimile recorder requires a higher-priced receiver.

[Courtesy "F.M. and Television"

All the actuating mechanism is contained in this facsimile unit for operation from a standard F.M. receiver.

The author points out that even when standards of transmission and reception have been settled, it will remain for somebody to start a regular daily facsimile service for home reception. The interest shown by newspapers in facsimile is said to be only in so far as it is a "potential competitor." "Why," asks the author, "should a newspaper go into facsimile unless it is forced to do so by some other organization that may embark on this service as a means of entering the newspaper field with no more investment than the cost of an F.M. station?"

Television Receiver Construction



9—The Power Unit : Some General Notes

THE power requirements of a television set are considerable and the power unit is consequently much more massive than that of a sound receiver. All the L.T. can be supplied by a single 6.3-V, 8-A winding, but it should be noted that if a different cathode-ray tube is used an extra winding for it may be needed. Some tubes have 2-V heaters and some again have a heater-cathode voltage rating which does not permit the application of the signal to the cathode. In some cases, therefore, it will be necessary to have an extra winding on the transformer for the tube heater.

For H.T. a supply of some 250 mA at 500 V is needed. Because of the widespread use of electrolytic capacitors in various parts of the equipment the output voltage must not be allowed to rise above 500 V at any time. As all valves are directly-heated types the load on the H.T. supply is negligible until they have warmed up and with a directly-heated rectifier the initial voltage would rise to about 700 V. An indirectly-heated rectifier (or a time-delay switch) is therefore essential, but such rectifiers with a 250-mA rating are uncommon. Cossor list one—the 45IU—and this has been used successfully in the equipment. The circuit of Fig. 1, however, shows two 120-mA rectifiers as these are more usual and probably more generally obtainable.

The reservoir capacitance C_1 is 4 μF and of at least 750-V working. Actually, two 2-μF capacitors of 900-V rating were used since they were more readily available than a single 4-μF unit. The main smoothing capacitor C_2 is of 32 μF, rated at 500 V.

The choke L has an inductance of 20 H at 250 mA and must be of low D.C. resistance; the component used has a resistance of 185 Ω. The full voltage after the

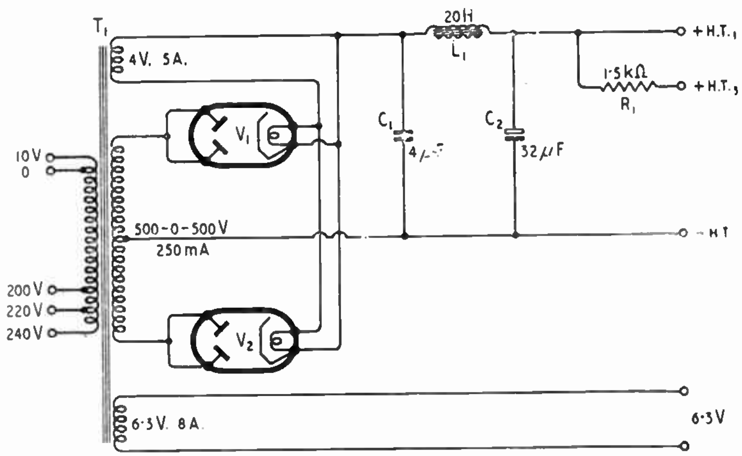


Fig. 1. The circuit of the power unit is shown here. The total input required is about 200 VA.

choke, 480 V, is taken to $+H.T._1$, and is dropped to about 300 V in R_1 to provide the output $+H.T._3$. The power loss in R_1 is about 15 W and a component of 20 W rating is used. As it gets quite hot it should be mounted above the chassis in a position permitting free air circulation.

Very heavy flex leads must be used for the heater connections between the power unit and the equipment; 120/36 (i.e., 120 strands of No. 36 gauge wire) is about right. If such heavy flex cannot be obtained it may be simulated by paralleling, say, five lengths of ordinary lighting flex.

Little need be said about the construction, for this is quite straightforward, and the layout is governed mainly by the desirability of keeping capacitors well away from hot parts like the valves and the resistor. Steel is an obvious choice for the chassis in view of the heavy components. However, it is not very readily obtainable and is not easy to bend, so the experiment was tried of using No. 16 gauge aluminium sheet. This resulted in a surprisingly stiff chassis, largely because of the stiffening effect produced by the transformers and choke, and this material has proved quite satisfactory.

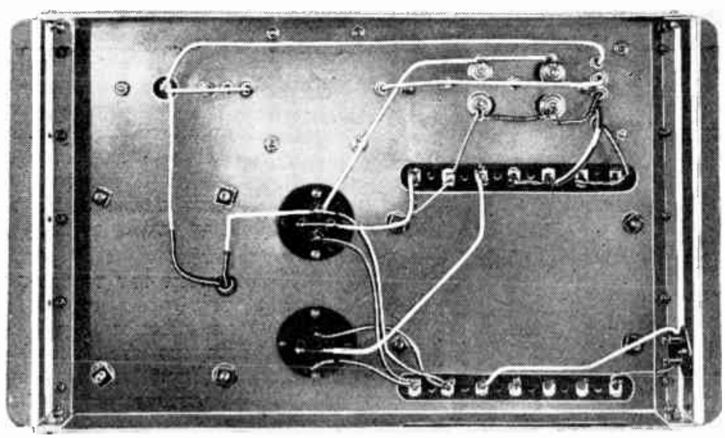
Details of the whole television set have now been given, but before concluding it will be as well to deal with a number of points which have not been fully treated.

First of all, the aerial and feeder should have some mention. It will be clear from Parts 7 and 8 that the receiver is designed for use with a 70-Ω coaxial feeder and this must be regarded as essential if the set is to be used at anywhere near full gain. With a twin unscreened feeder the set will become unstable near full gain through feedback introduced by stray coupling to the feeder.

A twin-feeder would, of course, be quite wrong with this set in any case because the input circuit is not designed for it and it would operate in a completely unbalanced condition. Nevertheless, it can be used in areas of very high field strength where nothing like full gain is needed.

In such areas but little in the way of an aerial is necessary so far as signal pick-up is concerned and one can take very great liberties with aerial and feeder. An indoor aerial is then often satisfactory, but in the writer's experience it is most unsatisfactory to have an aerial in any living room. Although adequate signal pick-up may be obtained, it is found that the signal varies enormously as one moves about the room. Moving only a few feet near the aerial may so alter the signal that the picture changes from overload to black-out.

Any indoor aerial must thus become a loft aerial so that it can be well away from anything movable. A proper feeder is then necessary. As an indication of what is possible in an area of high field strength, the writer has used the set at some three miles from Alexandra Palace. With the set in an upstairs room and a simple half-wave centre-fed dipole hung by one end from the gutter and about 20ft of twin unscreened cable for the feeder, quite satisfactory results were obtained.



Under view of the chassis which measures 14 in by 9 in by 1½ in.

The aerial was inefficient, for it hung only six inches from a wall on the side of the house remote from the transmitter, and the feeder was quite unbalanced at one end. Nevertheless, the signal pick-up was quite adequate.

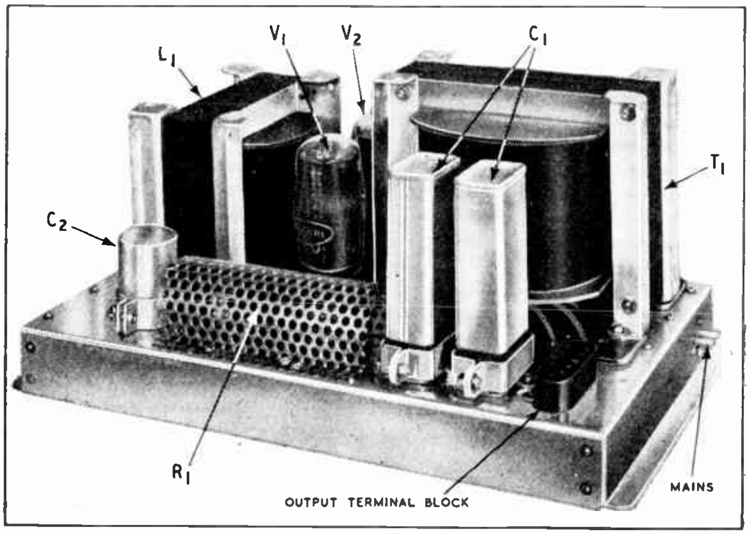
At greater distances, of course, much more attention to the aerial is necessary, but over a radius of five miles from the transmitter it will rarely be necessary to use more than a simple half-wave dipole. At greater distances the addition of a reflector may become advisable, and this is especially the case where reception is subject to interference.

If ghost images are obtained they will almost invariably be caused by multi-path propagation between the transmitter and receiver. Ghosts can be caused by defects in the receiver and/or feeder, but are very unlikely in this equipment and with a feeder less than 100ft in length. It will usually be found, therefore, that the remedy for a ghost image is to position the aerial so that it is responsive mainly to the signal travelling over one path only.

This is not always possible, but it is often found that the movement of the aerial by only a few feet does have a very big effect. The use of a reflector is also very helpful, since the aerial can be rotated so that its minimum response falls along the path providing the ghost signal.

This is often the best way of dealing with other forms of interference which may be encountered. Diathermy apparatus, which produces a pattern, something like watered silk, across part of the picture, can often be dealt with by rotating the aerial so that its null falls on the interference.

No serious interference problems are likely to be encountered



General view of the power unit showing the arrangement of the parts.

Television Receiver Construction—

with this receiver for it is of only moderate sensitivity and intended only for use in areas of medium and high field strength. Interference naturally becomes most troublesome in areas of low field strength and the use of special suppression circuits then becomes desirable. As has already been stated, a further receiver unit incorporating such suppressors and intended primarily for areas of low field strength is to be described in a future issue of *Wireless World*.

Some mention should be made of the Contrast Control on the receiver unit. This is the R.F. gain control, varying the bias on the first two R.F. stages. Some surprise may have been felt in reading Parts 7 and 8 to see that it is a pre-set control. In the writer's experience this is all that is needed, for the day-to-day variations are usually not in signal strength so much as in studio lighting and the ambient lighting of the viewing room, and these are best corrected by the Brightness Control.

However, in a few cases where the signal itself varies, it may be desirable to have Contrast as a panel control and the resistance is so mounted on the chassis that this can be readily arranged with either a simple bevel-gear drive or a system of cords and pulleys.

In Part 6, it was said that with certain cathode-ray tubes the internal connection of heater and cathode precludes the feeding of the V.F. signal to the cathode. With such tubes it is necessary to have an extra phase-reversing stage.

There are also certain tubes available which, although having an insulated heater and cathode, are not rated in such a way that one can safely adopt the precise connections used for the MW 22-7.

In view of a number of requests for information about how such tubes can be used, the concluding article in this series will contain details of the modifications needed for the cases of (a) tubes having a low heater-cathode voltage rating, and (b) tubes having heater and cathode internally joined. For reference, the articles which have already appeared are listed below. Many of these are now out of print, but a reprint of the whole series will be made as soon as possible after the last one has appeared. This will not include the high-sensitivity receiver which is to be described at a later date.

The previous articles in this series are:—

1. Deflector Coils: General Principles. January 1947, p. 2.
2. Line Deflector Coils: Winding Data. February 1947, p. 40.
3. Frame Coil Winding and Deflection Yoke Assembly. March 1947, p. 103.
4. Frame Time Base and Sync Separator, May 1947, p. 164.
5. Line Time Base and E.H.T. Supply. July 1947, p. 251.
6. Cathode Ray Tube Mounting. August 1947, p. 278.
7. The Receiver Unit. September 1947, p. 330.
8. The Receiver Unit (*Continued*). October 1947, p. 391.

LIST OF PARTS.

C_1, 4 μF, 750 V working (2×2 μF, 900 V used) Dubilier Nitrogol.

C_2, 32 μF, electrolytic, 500 V working. Dubilier Type CT.

L_1, Smoothing Choke, 20 H, 250 mA, 185 Ω. Partridge 4204 B.

R_1, Vitreous resistor 1.5 kΩ, 20 W. Welwyn.

T_1, Mains transformer: Primary, 10-0-200-220-240 V. Secondaries, 500-0-500 V, 250 mA. 4 V, 5 A; 6.3 V, 8 A. Partridge 4204 A.

V_1, V_2, Indirectly heated 500 V, 120 mA rectifiers, Osram MU 12/14, Mullard IW 4/500, or equivalent, or one 500 V, 250 mA, rectifier, Cossor 45 IU.

NEW BOOKS

Sound Motion Pictures Recording and Reproducing. By James R. Cameron. Pp. 598 + index. Published by Cameron Publishing Company, Coral Gables, Florida, U.S.A. Price $9.50.

ONLY two books readily come to mind when seeking authoritative works on motion-picture sound engineering; namely, Lester Cowan's *Recording Sound for Motion Pictures* (McGraw-Hill, 1931) and the Research Council of the Academy of Motion Picture Arts and Sciences' volume *Motion Picture Sound Engineering* (1938). A third might be this 1947 version of a well-known text on sound-film recording and reproduction, which is now in its sixth edition.

Much of the original material has been re-written and sections on 16-mm recording and projection (about 30 pages) added, as well as chapters on laboratory and studio practice. 159 pages are devoted to a comprehensive historical survey of the photographic and electro-acoustic aspects of the subject. Disc recording receives a glancing reference in 14 pages.

The fundamentals of sound and light, systems of sound-film recording (the R.C.A. and M.G.M. equipments are fully described), re-recording, mixing, lighting, the camera, microphone technique, and reproduction, are all touched on in the remaining chapters.

The illustrations and diagrams are interesting and plentiful, although the half-tone reproductions are of poor quality. An index is included. This non-mathematical volume can be recommended, particularly to the beginner, as a helpful general survey of the field.

A few copies of the book have been imported into this country by The Modern Book Co., 19-21, Praed Street, London, W.2, and are sold at the high price of £3.

D. W. A.

Television Simplified. By Milton S. Kiver. Pp. 375 + vii with 222 illustrations. Macmillan & Co., Ltd., St. Martin's St., London, W.C.2. Price 27s.

IN his preface the author says that the purpose of this book is to bridge the gap between sound and television receivers in order to assist those who will be called on to repair television equipment. He has succeeded in his purpose and the book forms a very useful introduction to television.

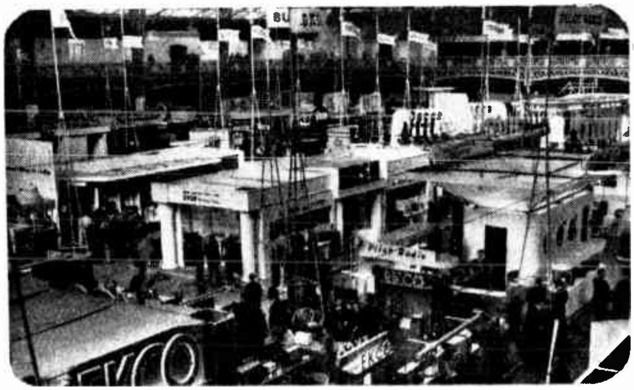
Being of American origin, the examples are naturally culled from American practice and this inevitably detracts from its value to the British reader. At least 50 per cent of the material, however, is equally applicable to the television systems used in the two countries.

The general principles of television are included, together with descriptions of the properties of very short waves and of television aerials. Wide-band amplifiers, detectors, V.F. amplifiers, D.C. restoration, C.R. tubes, deflecting systems and synchronizing are treated in more detail but non-mathematically. Chapters on colour television, frequency modulation and the complete receiver are included.

There are a few errors, but very few, and the descriptions of the operation of circuits are clear and likely to be of particular assistance to the beginner in television. The chapter on deflecting systems is rather weak, however, and the experimenter will soon find that only a fraction of the whole story is told.

W. T. C.

Show Review



TECHNICAL TENDENCIES REVEALED AT OLYMPIA

Wireless World presents a detailed review of high lights and present tendencies in the design of the main classes of radio equipment as exemplified at the recent National Radio Exhibition.

Broadcast Receivers

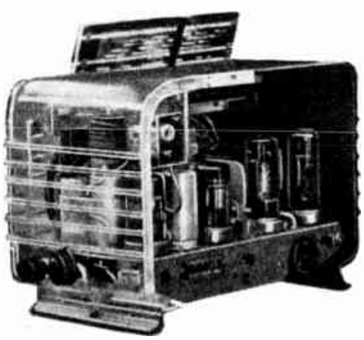
THE typical broadcast receiver of to-day is the four- or five-valve set (including rectifier). It has three wavebands—long, medium and short—and is a superheterodyne with a triode-hexode frequency changer. It has a two-gang variable capacitor for tuning, one section for the oscillator and the other for the single-tuned circuit which couples the aerial to the grid.

A single I.F. stage is used with four tuned circuits arranged as two coupled pairs and operating at a frequency of 450-470 kc/s. The two diodes of a multiple valve provide detection and A.G.C. Delay for the latter is usually provided by the bias resistor of the multiple valve in which the diode is included. The A.G.C. is usually applied fully to the mixer and partially to the I.F. valve.

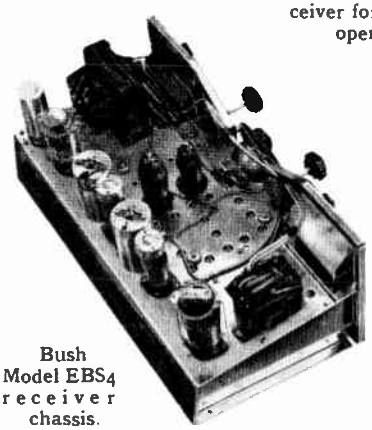
In the four-valve sets the main section of the multiple valve is an output pentode, but in the five-valve types it is a triode, resistance-capacitance coupled to a separate pentode output valve. Negative feedback is then often used.

In their circuits sets of this type differ but little from their pre-war counterparts. In some ways they are simpler, for push-button tuning has been largely abandoned. This is mainly an economy measure, for it is retained in the more expensive sets, but even then the pre-war lavishness of ten or a dozen buttons is replaced by four to six only. "Magic-eye" tuning indicators, too, have largely disappeared and are now rare on anything but the more expensive sets.

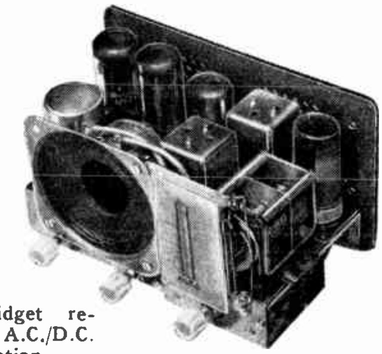
Although it will pass unnoticed by the casual observer, for it can be seen only by delving into the interior, the standard of workmanship is much higher than before the war. The mechanical construction of even the cheapest sets is much better, and in addition far more attention is now paid to accessibility.



Philips 209U receiver with exhibition cabinet.



Bush Model EBS4 receiver chassis.



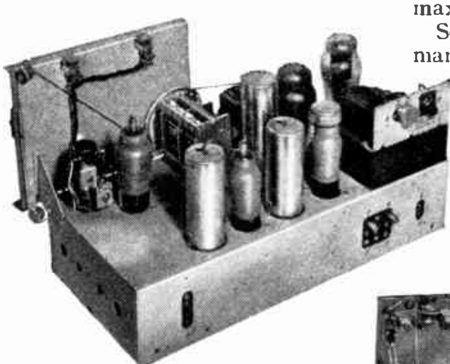
Alba midget receiver for A.C./D.C. operation.

In the case of A.C./D.C. sets safety is also given considerable attention. In such sets the chassis is usually in direct connection with one side of the mains and so is a source of danger to anyone contacting it. To obviate this possibility the cabinet is arranged to prevent such contact and grub screws in the knobs are deeply sunk in them.

One good example of this is the Beethoven 4-valve Model 2038 The cabinet is of moulded plastic and is available in various colours. It drops over the complete chassis and the two are screwed together from underneath. A bottom cover plate is then secured with screws passing into moulded inserts in the case.

One new feature this year is fly-wheel tuning. The idea itself is not new, of course, and there have probably been examples on the market for ten or fifteen years, but there have never before been so many sets with it. Disguised under various names it is to be found in probably as many as fifty per cent of the sets at Olympia.

It is obtained by fitting a heavy flywheel to the shaft of the tuning control. If the control knob is spun the inertia of the flywheel then carries on. Its use thus makes it easier and quicker to pass from one end of a tuning range to the other, and it also improves the "feel" of the control.

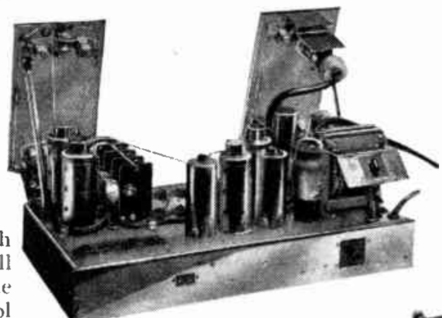


Pye Model 38G export model.

Much depends, of course, on the amount of friction used, and this varies considerably in different sets. With but little friction a single spin will easily carry the tuning across the whole range, but when the control is very free it is less easy to set it precisely, and the slightest touch to the control knob moves it appreciably. In most sets, therefore, appreciable friction is provided, and several spins are needed to carry the pointer across the scale.

Flywheel tuning is fitted in the Pye Model 48A, which is a 4-valve A.C./D.C. set, having a coverage of 16.3-51.8 metres for its short waveband. This set also includes another feature of many, if not most, post-war sets. This is the use of switched instead of a continuous tone control. The number of "tone positions" varies. In the Pye set it is four, and the on-off switch is controlled by the same knob. A good point is that the "fidelity" position is adjacent to the "off," since it decreases the probability of the set's being always used with the maximum top cut.

Sets of this general type are in many cases also available as special export models, some of which are built for 6-V battery operation, a vibratory converter being used for the H.T. supply. These differ from the home types chiefly in the replacement of the long

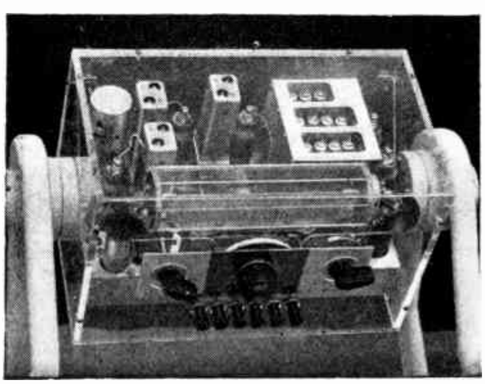


Peto-Scott HE71 chassis with two tuning systems and scales.

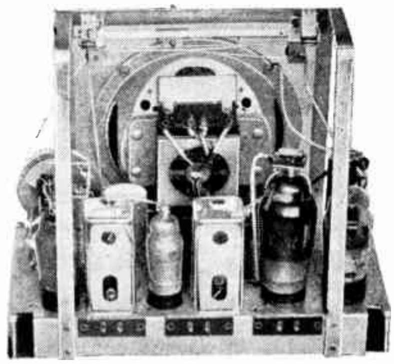
waveband by an extra S.W. band, the use of tropical components, and the provision of a tuning scale calibrated for the area of use. One such set the Ultra EV4053, can be supplied with a dial in Arabic.

Another Ultra set, the T49, is noteworthy for the easy access to its interior. By undoing two screws the chassis can be lifted on hinges.

A new feature of some interest as indicating the public dislike of aerials, however desirable they may be tech-



Radio unit of the Deccola radio-gramophone.

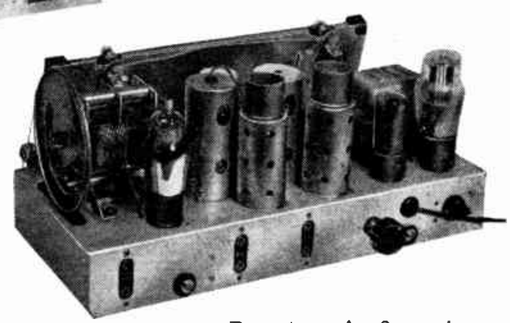


Chassis of Beethoven Model 2038 receiver.

nically, is the inclusion of frame aerials in small table models. To cover the S.W. band a plate aerial is sometimes fitted to the top of the cabinet.

One example of a set of this type is the Ferranti Model 547, a 5-valve A.C./D.C. set covering medium and long waves only.

Several sets of more or less the basic type so far discussed are fitted with an electric clock arranged to switch the set on or off at predetermined times. The Ekco model, which measures only

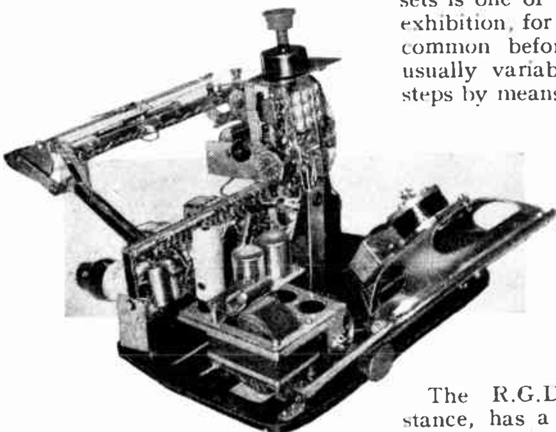


Regentone A358 receiver.

11in by 5in by 5in, has six pre-set stations and frame aerial. If the selected station happens not to be operating when the set switches itself on, it produces an audio tone as an alarm.

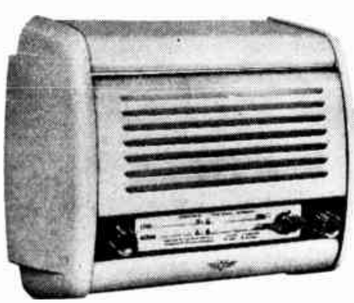
It should be mentioned that sets of this general category vary greatly in size and range from the so-called midget to fairly large table models with wooden cabinets. The larger models generally tend to a better performance if only because they include a larger speaker, and the cabinet provides a better baffle area.

An example of a general tendency towards improvement in tone control is afforded by the Bush Bi-Focal Tone system. In this the frequency response of the A.F. amplifier is controlled by a variable negative-feedback system linked to the volume control in such a way that the upper frequency limit rises as the volume control setting is lowered. The



A.G.C. system is so adjusted that the detector output is greater on strong signals than on weak, so that the volume control setting must be reduced on the former to maintain the same sound level. This, of course, increases the upper cut-off frequency and gives improved reproduction on strong signals with which the noise level is normally low and which are thus suitable for high-quality reception.

Turning now to the larger sets we rapidly pass beyond the region of uniformity. In general, however, the changes are of two kinds which may, or may not, be combined. On the one hand sets may have more S.W. bands and improved tuning systems and may



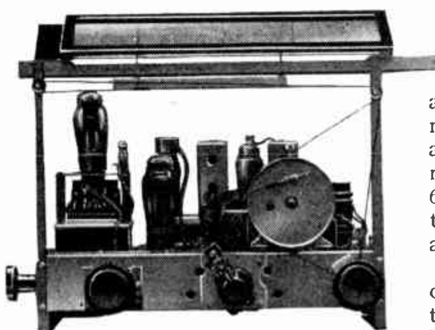
Kolster-Brandes space-saving set for mounting high up on a wall.

also incorporate an R.F. stage. On the other hand, the A.F. side is improved; better speakers are used, push-pull output stages are included, and variable selectivity is provided in the I.F. amplifier and often combined with the tone control.

The inclusion of variable selectivity in so many of the bigger sets is one of the surprises of the exhibition, for it was by no means common before the war. It is usually variable in two or three steps by means of a switch, which often also controls the response of the A.F. amplifier.

Ultra T49 chassis with hinged units partly opened to show accessibility for servicing.

The R.G.D. 1046G, for instance, has a 3-position control; in two positions the I.F. transformer coupling is varied, while



Ekco A52 chassis. As well as wavechange the centre knob permits the selection of a number of pre-tuned stations.

in the third extra damping is added to the circuits. This set, incidentally, has an R.F. stage, triode-hexode frequency changer, one I.F. stage, and a duo-diode-triode. The associated A.F. amplifier has an A.F. stage, a phase-splitter and a pair of triodes in push-pull. The tuning range is 13 metres upwards.

The Decca R.F. unit, however, has continuously variable selectivity, the coupling in two transformers being varied by a panel control. The set has eight bands, covering the medium and long waves as well as narrow bands

H.M.V. trolley-mounted radio-gramophone (Type ED2) for use in schools.

around 13, 16, 19, 25, 31 and 49 metres. An R.F. stage is included and an amplified A.G.C. system maintains a push-pull output of 6 V at less than 0.5 per cent distortion. The amplifier is separate.

The H.M.V. Model 1700 is another set to include variable selectivity and amplifier A.G.C. It has inter-station noise suppression and push-button control. It is a most elaborate equipment, using no fewer than 43 valves and covering 12-2,000 metres in twelve bands as well as giving F.M. reception of 90-94 Mc/s. R.F. switching and tuning are carried out by motor drives, and there is an A.F.C. circuit. Remote control provides the selection of any one of four medium and two long-wave stations or gramophone. A time switch is included and is linked with the station selector. The output of 50 W is fed to four speakers; there are three elliptical cone type, two large and one medium, and a ribbon diaphragm horn speaker for high frequencies

The Dynatron tuner has two

Show Review—
I.F. and one R.F. stages; variable selectivity is switch-controlled in four steps. A 9-kc/s whistle filter is included and is a form of bridged-T network giving an attenuation of 40 db. The associated amplifier has a push-pull triode output stage and negative feedback is used.

Among the many special receivers produced is the R.M. Electric high-fidelity local-station set. It has one R.F. stage and an infinite input impedance detector followed by a tone control stage, an A.F. amplifier, phase-splitter and push-pull output.

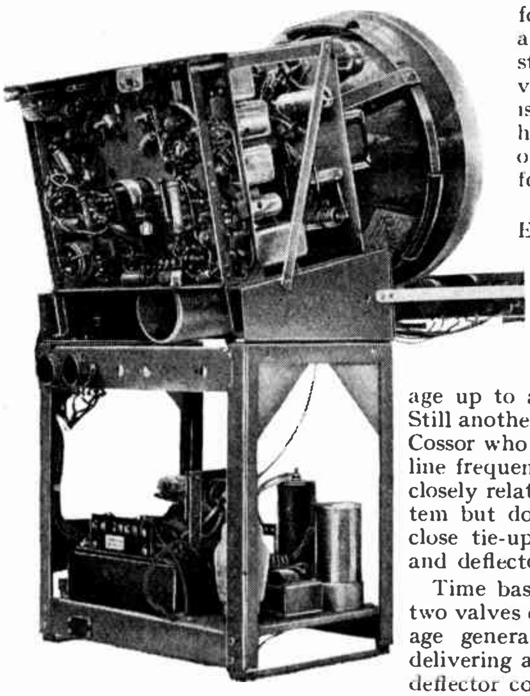
Other specialized receivers were those for use in schools. Manufacturers exhibiting such equipment included H.M.V., with a range of four radio-gramophones, and Ultra, whose equipment is to be fitted in many L.C.C. schools.

Murphy have a Commercial Tropical M.W. set. It is a superheterodyne for 12-V battery operation with a push-pull output stage delivering 7 W.

Television

IN spite of the fact that television is now very far from being a new thing there is but little uniformity in the products of different firms. The only thing common to all sets is the use of electromagnetic deflection. Tube sizes vary from 9in to 15in, the commonest being 9in and 12in.

Big efforts have been made to simplify the operation and it is common to find only two panel controls—sound volume and picture brightness. There are always subsidiary controls, such as focus, contrast, line and frame hold, which are concealed somewhere. In a few cases they are accessible from the front by removing a cover-plate, more often they are at the back or on one side.



Chassis of Murphy television receiver.

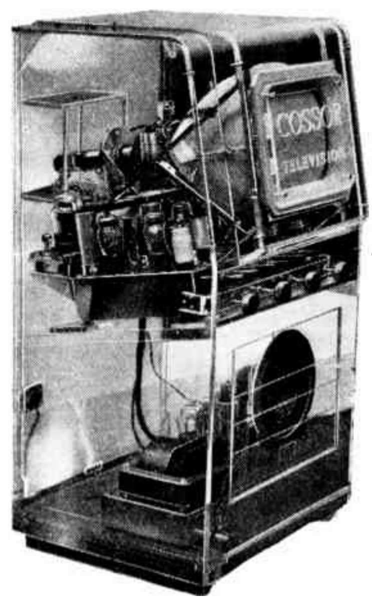
There is a general tendency towards the use of higher E.H.T. voltages than before the war and a figure of 6 kV is now common. In most cases it is still taken from the 50-c/s supply mains through a transformer and valve rectifier, but other methods are making their appearance. Kolster-Brandes, Mullard, and Philips for instance, derive it from the peak voltage which appears during the line fly-back, the primary of the line-scan transformer being used as an auto-transformer to step it up to a suitable value. A valve rectifier is used with its filament heated from a winding on the same transformer.

Ekco, however, take E.H.T. from a special oscillator operating at 140 kc/s. A triode power oscillator is used and its coils have a winding which steps the voltage up to a suitably high value. Still another method is adopted by Cossor who utilize a coil pulsed at line frequency. This is a method closely related to the fly-back system but does not involve such a close tie-up between the E.H.T. and deflector systems.

Time bases nearly always have two valves each; a saw-tooth voltage generator and an amplifier delivering a current output to the deflector coils. For the line scan the amplifier is invariably a pentode-type valve, but for the frame a triode is not infrequent. For the saw-tooth generators, thyratrons are common, but blocking oscillators are favoured by many firms, including Baird, Cossor, Ferguson, Kolster - Brandes, H.M.V., Marconiphone, Mullard, Philips and Pye.

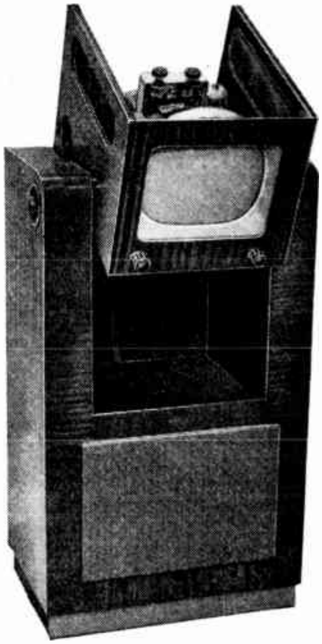
Line-scan damping is invariably provided by the series combination of a resistor and a capacitor across the line deflector coils. No case was observed of the use of a damping diode.

Ferranti practice differs considerably from that of other firms in the use of a saw-tooth current generator to feed the line-deflector coils directly without an intermediate amplifier. Another unusual feature lies in the use of high-inductance coils for the line scan and low-inductance for the frame. This last is fed through a transformer from a pentode amplifier which is itself driven by a Transitron Miller integrator saw-tooth generator.



Cossor Model 902 television receiver with 10-in tube in transparent exhibition case.

The deflector coils themselves are usually of the "bent up end" type with an outer iron circuit and are of low inductance, fed through transformers. In some cases, however, only the line coils are of this type and the frame coils are of high inductance and wound around opposite limbs of the iron circuit. They are connected in opposition in order to produce a magnetic field across the tube. Cossor, Haynes, and Sobell all use this form of construction and a surprisingly small quantity of iron seems to be needed. R.G.D. adopt still another form of construction. Here a circular iron



Beethoven T907 television set with cover of tube unit removed and unit partly closed.

circuit is used and toroidally wound. The winding is then cut into an appropriate number of sections which are connected in opposing pairs for each of the two deflections. Then again, Dynatron adopt a lamination with pole pieces and the windings are similar in form to those of an armature.

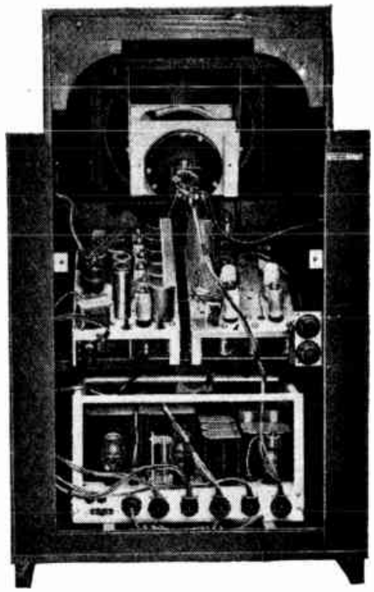
For focusing an electromagnet is nearly always used. In the Baird sets it is fed through a pentode to maintain constant current, but it is usually connected in series with or across the H.T. supply without special precautions. Some firms, notably Cossor, Ferranti, Kolster-Brandes, use a permanent magnet with an adjustable shunt for the focus control.

The sync separators vary considerably. Sometimes there is a double diode fed from the cathode circuit of the V.F. stage as in the Bush set, but many prefer a pentode separator. An unusually complex arrangement is adopted by Sobell. The separator starts with a phase-splitter, from the anode of which a diode limiter is fed. This produces the line sync pulses. The cathode of the phase-splitter feeds the cathode of a pentode separator having a critical time constant which produces an output coincident with the rear edges of the frame sync pulses. This output is fed through a further diode to the frame time base.

It is in the receiver proper that most differences between sets occur. One V.F. stage is always used and is fed from a diode detector, usually a half-wave type although occasionally a full-wave detector is employed. In most sets the V.F. stage feeds the grid of the C.R. tube, but there are many in which it feeds the cathode—for instance, in the Alba, H.M.V., Marconiphone and Pye sets.

Noise limiters are frequently included and often take the form of a biased diode in shunt with the input of the tube. Pye favour a negative-feedback system in which the diode is connected between grid and cathode of the V.F. stage and Sobell have a form of "black spotter." In this the V.F. stage feeds the tube grid directly and the cathode through a biased diode.

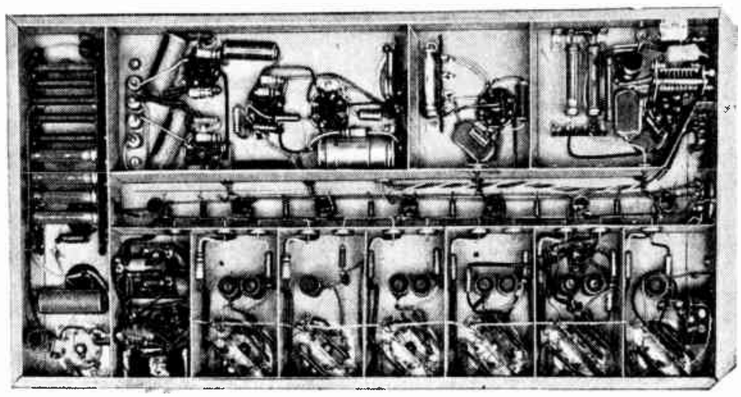
The biggest differences between sets lie in the pre-detector stages, where not only the straight set and the superheterodyne compete for favour, but there is also rivalry between single- and double-sideband methods of



Interior of R.G.D. television set.

operation. The advantages of single-sideband working are, first, higher gain per stage because of the narrower bandwidth needed, and, secondly, the fact that by choosing the sidebands remote from the sound channel the rejection of this last is much easier. The main objection to it is that circuit alignment must be more accurately carried out if the equivalent response is to be secured.

Probably most sets are double-sideband straight receivers with four R.F. stages in the vision channel, although some use five (Dynatron) and even six stages (Haynes). The first, and sometimes also the second, R.F. stage



Underview of the R.F. unit of Haynes television set.

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is usually common to both sound and vision channels. The sound receiver itself is sometimes also a straight set (Pye), but is quite frequently a superheterodyne as in the Bush and Haynes sets. Sound-channel rejection usually demands the use of a number of rejector circuits, and a favourite method is to include them in the cathode circuits of the later R.F. valves. Ekco, however, adopt a form of bridged-T network as the coupling element of a bandpass filter. The circuit is shown in Fig. 1 and L tunes with C_1 and C_2 to the sound channel. The resistance R has the effect of balancing the coil losses and makes it behave as though they were zero at the resonance frequency.

Single-sideband operation is adopted with the straight set by both Cossor and Sobell. Four R.F. stages are used in the latter and the sound channel is quite separate; it also is a straight set and has two R.F. stages.

The superheterodyne is favoured by H.M.V. and Marconiphone. Usually there is an R.F. stage, mixer and three I.F. stages and the sound signal is taken either from the mixer output or after the first I.F. stage. In the R.G.D. double-sideband model the frequency-changer has a separate oscillator valve and the sound signal is separated after the first of the three I.F. stages. Kolster-Brandes, however, adopt single-sideband operation.

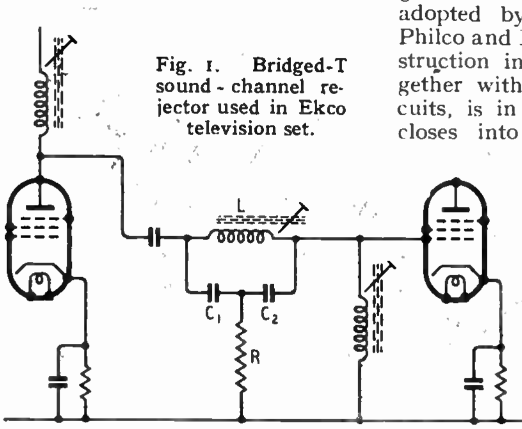
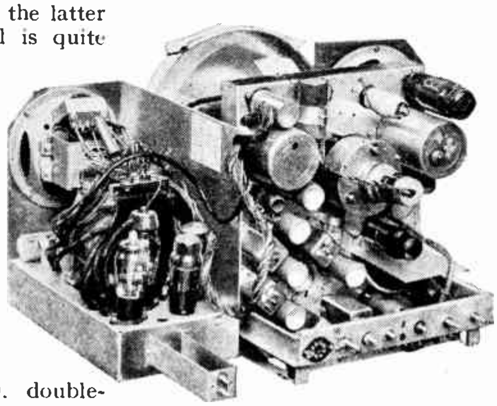


Fig. 1. Bridged-T sound-channel rejector used in Ekco television set.

In their mechanical form television sets are in most cases both more compact and more accessible than formerly. A sub-unit construction is common, but the sub-units are bolted together with a framework which is often removable from the cabinet as a whole. Miniature valves are nearly always used for the R.F. and I.F. circuits and have materially contributed to the reduction of size.

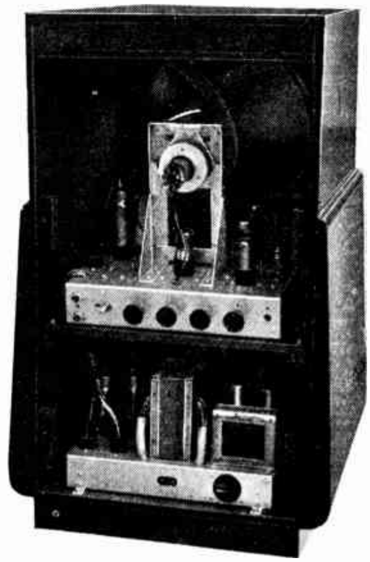
Considerable pains have been taken to reduce the mechanical vibration of the line-scan transformer and in at least one case it is enclosed in a heavy die-casting. Panel controls are usually only two—volume and brightness—but sometimes focus and tone are added.

In most sets no attempt is made to conceal the C.R. tube when it is out of use, but a number of ingenious arrangements has been adopted by some firms. Both Philco and Beethoven have a construction in which the tube, together with some associated circuits, is in a hinged case which closes into the cabinet proper when the set is out of use.



Rear view of Ferranti television receiver.

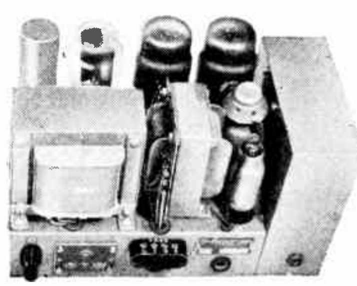
Sobell have a hinged and sliding panel which covers the tube and also serves as the tuning scale of an associated broadcast set. The "pointer" of the scale is a beam of light from a lamp carried on the tuning shaft and each of the scales carries a small prism behind it which reflects the light on to the face of the scale.



Rear view of the Kolster-Brandes CV40 television set.

Most sets have 9in or 12in tubes, giving pictures 7½in by 6in and 10in by 8in. There are a few with 10in tubes, however, and some with 14 or 15in tubes. Cossor and Haynes both have sets with these large tubes. Baird have in their Grosvenor model an outsize. It is a back-viewing tube with the gun at an angle to the screen and consequently requires keystone correction. It provides a picture 22in by 19in.

On the transmitting side of television E.M.I. have a new film scanner. "Flying-spot" scanning is used from a raster produced on a C.R. tube. The success of the scheme depends on the E.M.I. Multiplier Photo-Cell which has



Acoustical Manufacturing Company's Model QA12/P quality amplifier.

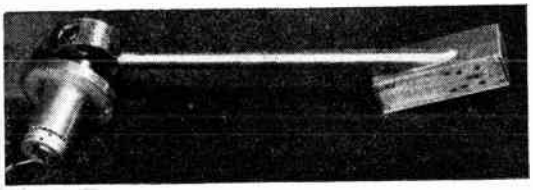
nine stages of secondary emission amplification and an overall sensitivity of 1 to 20 amperes per lumen. One of the great practical advantages of the scanner lies in the elimination of spurious responses needing tilt and bend signals for their correction.

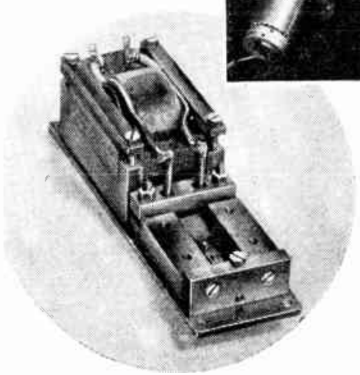
Sound Amplification

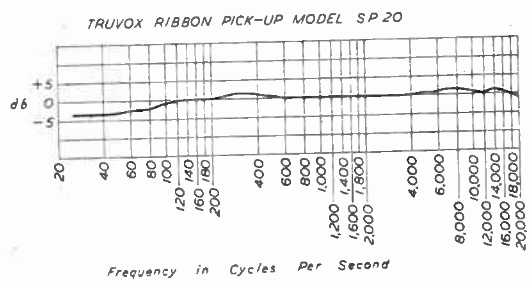
MICROPHONES for public address work have improved both in efficiency and reliability. Examples of ribbon and transverse current carbon types were shown, but the majority were of the moving coil variety, in which modern magnet steels and metal diaphragms had been employed to reduce size and give protection from moisture.

Pickup design has shown considerable advances over pre-war standards and very few of the clumsy designs requiring several ounces to keep them in the groove have survived. Decca were among pioneers of the lightweight pickup and their present model has a half-rocker moving-iron movement, with rubber-mounted replaceable armature. This pickup, with its permanent sapphire stylus, is used in the "Decola" full-frequency-range electric record reproducer.

Truvox have been very active in the pickup field recently and were showing three new designs which show a firm grasp of essentials. The "Ferrocoil," which is a combination of the moving-iron and moving-coil principles, gives an output of 1 volt R.M.S. from the secondary of a 120: 1 transformer. The "Concert" moving-coil gives 7 mV from the 60: 1 matching transformer after frequency correction and the "Ribbon" pickup gives 8 mV under the same conditions (a built-in preliminary transformer matches the ribbon to the 7-ohm input to the 60: 1 transformer). In all three designs the frequency of the resonance due to needle compliance is remarkably high—above 20 kc/s in the "Ribbon" and 12 kc/s even in the iron-cored "Ferrocoil" movement. This has been achieved by reducing the length and increasing the stiffness of the sapphire mounting, and by distributing the mass about the axis of rotation to give the minimum moment of inertia. The sapphire in the "Ferrocoil" incidentally is detachable and is mounted in a short 14 B.A. screwed shank.







Truvox "Ribbon" pickup with the maker's curve and close-up of head, with magnet removed, showing preliminary coupling transformer.

Judged by the crude but all-too-prevalent test of rocking the needle from side to side the Truvox movements appear to be stiff, but criticism on this score is superficial, for although the reaction at amplitudes of 20 or 30 mils is considerable, and can be felt, it is negligible over the range of amplitudes met with in recording. The "Ribbon" pickup is virtually a single-turn moving-coil in which the edge-on metal ribbon runs the length of parallel slots between the poles of the magnet and a centre soft iron pole piece. The magnetic field is uniform and the moving mass is less than 40 milligrams.

Amplifiers for sound reproduction ranged from the host of portable 5- and 10-watt models in brightly coloured cases, designed to catch the eye of dance band leaders, to the massive rack-mounted permanent installations for sound distribution in large factories. Typical of the latter class was the three-bay assembly shown by G.E.C., including the BCS1241 amplifier with two DA250s under-run in Class AB1 to give 500 watts, and the Dynatron rack-mounted system in which a wide choice of amplifiers, feeder and mixer units can be combined to meet most P.A. requirements. A noteworthy display was to be seen on Tannoy's stand in which the complexities of P.A. control in modern holiday camps were revealed by diagrams in conjunction with a full-sized control desk.

Amplifiers for quality enthusiasts, designed to reduce distortion below the usually accepted commercial limits were shown by Lowther and the Acoustical Manufacturing Co. In the QA12/P amplifier made by the latter firm the maximum pass figures in the final overall test for harmonic distortion up to 12 watts are: 2nd harmonic 0.2 per cent, third 0.3 per cent, higher orders 0.05 per cent. The frequency range is 20-20,000 c/s ±0.3 db and a filter for use with commercial recordings is available to exclude cross-modulation and other distortions which would otherwise be reproduced from commercial recordings. The filter (Type 20) is level to 6,000-c/s, 15 db down at 7,000 c/s and 40 db down at 9,000 c/s.

A useful general-purpose amplifier (Type R1) was shown by Birmingham Sound Reproducers. This is primarily a recording amplifier with seven-step bass and treble equalizer controls and a level-indicating meter with special dynamic characteristics.

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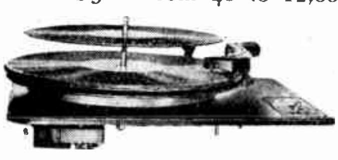
A three-position switch enables the same amplifier to be used for playback or for P.A. work.

Among quality loudspeakers it was good to be able to welcome back into production such well-

Goodmans Industries "Axiom Twelve" twin diaphragm loudspeaker.

tried models as the Rola G12, the Ediswan Senior R.K. and the Goodmans' twin diaphragm, now known as the "Axiom Twelve." This latter is rated at 12 watts peak A.C. and has a flux density of 13,000 gauss, total field 145,000 maxwells; the fundamental resonance is at 55 c/s and the useful frequency range is stated to be 40-15,000 c/s. The Lowther Manufacturing Co. were showing a permanent-magnet version of the Voigt twin-diaphragm unit with a flux density of the order of 19,000 gauss.

An interesting new unit for high-fidelity reproduction was shown by Tannoy. This was the "Concentric Dual" loudspeaker in which a pressure-type H.F. horn, starting inside the centre pole of the 15-inch L.F. unit is arranged to blend into the curved-sided cone, which is designed to give wide-angle diffusion of the higher frequencies. A frequency-dividing network with a cross-over at 1,000 c/s is included and the whole unit weighs 35 lb. It is claimed that the response is flat within ±3 db from 40 to 12,000 c/s and that cross-modulation is reduced to a minimum.



Plessey automatic record changer.

There is a tendency to use centre-pole magnets in loudspeakers intended for use in domestic radio receivers and television sets. The newer magnet steels lend themselves to this treatment and economies in materials as well as lower leakage flux losses are obtained. The method is carried to its logical conclusion in the Truvox "Wafer" series in which the diaphragm housing or chassis is utilized as a path for the completion of the magnetic circuit.

Cabinet reproducers combining bass reflex L.F. units with multi-cell horn H.F. units were shown by Truvox. The range of "Bitone" dual-channel instruments made by Vitavox has been extended by the addition of the Model 310 with three-cell H.F. unit and 12-inch L.F. cone. This is more compact than the standard models 610 and 620 and is intended for use with 16-mm sound-on-film equipments. The Wharfedale Twin Speaker Corner Cabinet makes use of cone units for both high- and low-frequency channels.

Tannoy "Concentric Dual" loudspeaker.

An extended bass response is provided in the "Concert Labyrinth" loudspeaker of the Acoustic Manufacturing Company by a combination of pipe resonances and phase shifts between back and front of the diaphragm, blended experimentally to give a smooth response curve in conjunction with the characteristics of the loudspeaker driving unit. The measured response curve in the open is not flat, but has been modified deliberately to give the best results when the loudspeaker is used in a living room of average dimensions and absorption coefficient.

Apparatus for sound recording was shown in much greater variety than in any previous show. The interest in this branch of electro-acoustics has resulted in the production of a number of disc recording machines capable of giving results at least equal to commercial pressings. A wide choice was offered by Simon Sound Service who specialize in the distribution of recording equipment. In addition to proprietary types of direct recorders for disc and wire, this firm was also showing a pickup location and control unit of their own design.

Gramophone turntable driven by two-phase motor (Electrical and Radiological Instruments).

The Type DR13 recorder made by Birmingham Sound Reproducers is designed for use in conjunction with their Type R1 three-purpose amplifier and a ribbon microphone. The turntable is belt driven from a synchronous motor and will take discs up to 13 inches diameter. Tracking is outside-to-inside and the groove pitch 96 per inch. The whole unit is transportable and an 8-inch monitor loudspeaker is mounted in the cabinet lid. Disc recording machines of the studio type were also shown by Tannoy and E.M.I.

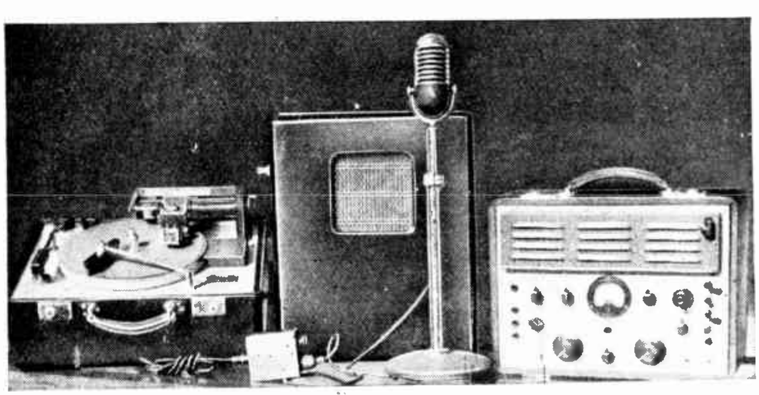
Several firms have produced magnetic tape recording machines using iron-oxide coated plastic

E.M.I. magnetic tape recorder.

tape. Notable examples shown were the E.M.I. and G.E.C. models, designed for high-fidelity transcription work. A medium-fidelity model (up to 6,000 c/s), designed for use in the home, was shown by G.E.C. With a tape speed of 18 inches per second a playing time of 45 minutes per spool is provided. The G.E.C. machines make use of superimposed concentric feed and take-up spools, which effect a considerable saving of motor board area; the domestic model is slightly smaller than the average console receiver.

A portable disc recorder, suitable for dictation work, in which the recording medium is a flexible disc of iron oxide-coated plastic, was shown by E.M.I. The recording and playback head is carried on a pickup arm which is tracked by a stylus fitting into a spiral groove in a centre plate of plastic material. The turntable speed is 30 r.p.m. and the groove pitch is 40 per inch. A spring-driven turntable motor and self-contained battery amplifier occupy the lower half of the case, the lid of which cannot be closed until the removable tracking disc has been stowed in its appointed place. A strip magnet is provided to wipe off the record by holding the strip along a radius while the record is turning.

Gramophone motors and record changers are by no means in the doldrums and it is no secret that the products of our leading firms readily earn hard currency, even in countries that pride themselves on their mechanical ingenuity. The Plessey record changer, with its mechanism concentrated chiefly in the centre spindle, is notable for the small depth in which it can be accommodated. There is a tendency this year to make use of frictional drum drives for record turntables, a practice which has found favour in recording machines where high and constant torque is essential; examples were shown by Garrard and B.S.R. Constant torque and cool running under continuous load are claimed to be advantages of the two-phase motor developed by Electrical and Radiological Instruments. The motor is fed from a special transformer which converts a single-phase to a two-phase supply.



B.S.R. Type DR31 disc recorder, Type R1 three-purpose amplifier and ribbon microphone.

Car Receivers

THE design of car radio receivers has been markedly influenced by the availability of miniature components, but even so the majority of makers find it more convenient to adopt a two-unit form of construction as it provides greater flexibility and generally eases the installation problems in small cars.

Division of the receiver is sometimes done after the frequency changer, so that one unit contains the R.F. and frequency changer stages with all controls and the other the I.F. amplifier, detector, A.G.C., audio power circuits and loudspeaker. The R.F. and F.C. unit is usually called the control unit.

Romac Model 107 car radio receiver. A special shortwave version is available for export.

One example of this form of construction is the Radiomobile equipment. This set has a vibrator H.T. supply with valve rectifier—a combination favoured by several other makers. One of the Radiomobile models embodies push-button selection for four pre-tuned stations. It is a mechanical system and rotates the ganged tuning condensers by pre-determined amounts. Manual tuning is also provided and this is operated by a press-in clutch which prevents the tuning being disturbed by accidental movement of the control knob.

A similar mechanical pre-selection system is used by Masteradio in their models. Two-

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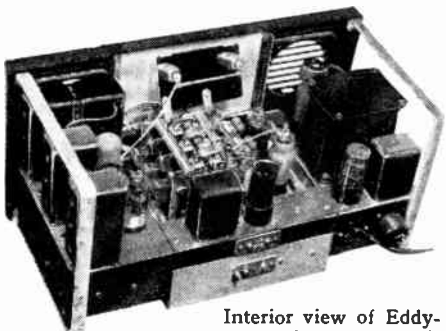
unit construction with the R.F. and frequency changer stages in the control unit is adopted. The two units can either be connected together to form a single assembly or stowed separately, as conditions demand. Masteradio supply a neat short-wave converter for the export market.

Short-wave facilities are provided also by Romac, who have a special export model. This also is a two-unit design with the R.F. and frequency changer in the control unit.



Interior view of Eddystone 640 communications receiver.

The same form of construction is used by Champion but Pye and Philco favour an all-in-one set, the judicious use of miniature components and valves making this quite practicable. Philco, however, have a separate tuning head with Bowden-cable controls. The Pye model is a real miniature measuring only $5\frac{13}{16}$ in × $5\frac{13}{16}$ in × $6\frac{3}{8}$ in, including the loudspeaker.

Communication Receivers

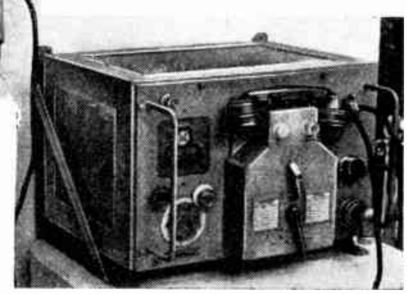
THE class of receivers commonly known as communication sets is one primarily designed for serious S.W. reception, including morse as well as telephony. Such sets are designed primarily for a good S.W. performance and for very high selectivity; a crystal filter is usually included and a beat-frequency oscillator.

The Eddystone Type 640 receiver is in this category. It has one R.F. and two I.F. stages with an intermediate frequency of 1.6 Mc/s and covers 1.7-31 Mc/s continuously. Two variable capacitors are used; one for band set, the other for band spread. The quartz crystal is vacuum mounted and the set is tropicalized.

Model 680 of the same firm has an intermediate frequency of 450 kc/s and covers the medium-wave band in addition to 1.34-30.5 Mc/s. An S-meter is fitted but there is no bandspread. There is a series-type noise limiter.

The Q-Max Type Q 5/10 has five bands and although designed for A.C. operation can be used with batteries with the addition of a battery unit. It includes a noise limiter and a crystal calibrator is available.

The Rees-Mace M7—a receiver in this communications category—is especially designed to give exceptionally low radiation from the oscillator. It covers 490 kc/s to 25 Mc/s.



Seamew radio-telephone for trawlers and small ships, made by the Marconi Company.

The G.E.C. BRT400 has a separate local oscillator for high frequency-stability and a logging scale with an effective length of $16\frac{1}{4}$ft. There are six fixed degrees of selectivity, three with a crystal and three without, giving bandwidths of 0.5-9 kc/s. A series-diode noise suppressor is used. The set covers 150 kc/s to 31 Mc/s in six bands.

Communication Equipment

MANY public and commercial services are now turning to the very high frequencies to provide local channels of telephonic communication. Such services as police, fire, harbour boards, towage companies and operators of other small craft are now finding V.H.F. radio ideal for their purpose, with the consequence that many radio firms are now making this class of apparatus, which is battery operated, using either 6- or 12-volt supplies. H.T. is invariably obtained from rotary convertors.

Several V.H.F. sets of this kind have been described in *Wireless World* recently; for example, equipment made by Eddystone, G.E.C., Marconi, Plessey, Pye and Standard Telephones. All these were at the Show and in addition similar installations were exhibited by Mullard whose Type GDR501 for vehicles and small craft operates on a spot frequency within the band 75 to 100 Mc/s, where these services are mainly located. Alternatively, it can be operated between 125 and 166 Mc/s.

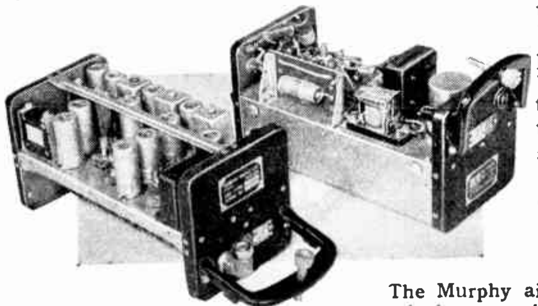
The transmitter and receiver are both crystal stabilized, the former delivering 20 watts of R.F. to the aerial. The receiver employs a double superheterodyne of high sensitivity. This equipment is frequency modulated using a deviation of ± 15 kc/s.

Frequency modulation appears to be gaining favour for this class of communication equipment, and the latest G.E.C. mobile radio-telephone also employs this system. The 20-watt transmitter is capable of spot frequency operation between 30 and 170 Mc/s. In this equipment provision is made for operation on a second channel which, however, must be not more than 400 kc/s away from the main one. Another facility is the use of the transmitter output stage as an audio amplifier delivering 8 watts to a loudspeaker for traffic control, or as a loud hailer for ships. There is also available an amplitude modulated version.

All makers of mobile equipment

also produce high power head-quarters transmitters, the usual carrier-power output being about 100 watts.

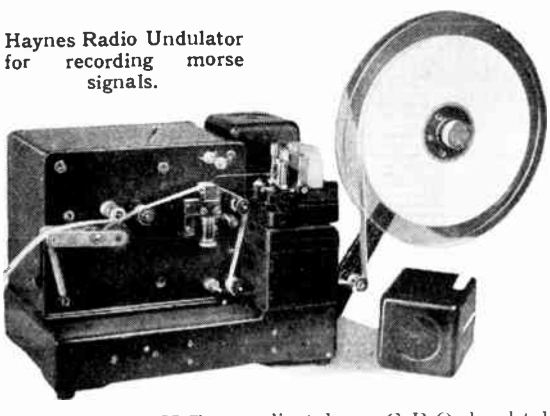
A novelty in radio telephones is the miniature Emiradio Pedestrian Trans-receiver with the microphone, telephone and aerial all included in one unit A



The Murphy aircraft V.H.F. radio-telephone receiver and transmitter (left) and power supply units removed from their cases.

separate battery box is required but even this is a miniature. It operates on a fixed frequency within the band 150-160 Mc/s.

Aircraft equipment was well in evidence at this Exhibition. Marconi's showing their general purpose installation AD97/108 and the new automatic direction finder which, together, with the G.E.C. radio compass, is described elsewhere in this issue. A newcomer to this field is Murphy, which firm now has a



Haynes Radio Undulator for recording morse signals.

lightweight V.H.F. radio-telephone operating on a single spot frequency between 100 and 120-Mc/s. Amplitude modulation is used and, although the carrier output is of the order of 0.25 W only, ranges up to 40 miles are obtained from an aircraft at 3,000 feet. H.T. is obtained from a vibrator supply unit and the total power input is 36 watts at 12 or 24 volts. G.E.C. also have a low-power lightweight radio-telephone designed mainly for civilian aircraft and operating in the same band. This and the Murphy set are crystal controlled throughout.

Marine radio equipment did not figure at the Radio Show before the war, but several firms were showing it this year. A representative display staged by the Marconi Company included the "Seamew" radio-telephone for use in trawlers and other small craft. It is for 24 volts battery operation and provides the choice of six channels of communication in the band 1.5 to 3.6 Mc/s. The receiver can be either pre-set to the selected six frequencies or supplied for continuous tuning. Facilities are provided for remote control of the set up to a distance of 50 yards.

Another trawler installation is the Mullard Type GMR501 which has eight crystal-controlled channels within the band 1.6 to 3.7 Mc/s. It is designed for 12-volt battery operation and the carrier output is 35 watts. Amplitude modulation is used in all this equipment.

A marine installation for working with tugs and other small river and harbour craft and designed for linking up to the G.P.O. land telephone system was shown by E.M.I. Although rather specialized it exemplifies the now extensive use of the V.H.F. radio-telephone by services which hitherto had relied on visual signalling.

Descriptions of communication equipment would not be complete without some reference to the radio amateur and his needs. Those who wish can now acquire commercially made transmitters designed especially for the amateur frequencies. A set of this kind was shown by Q-Max. Described as the B4/40 transmitter, it covers the 3.5-, 7-, 14- and 28-Mc/s bands giving 40 watts carrier output on each. Design data for transmitters is supplied by Haynes Radio and Stratton.

Test and Servicing Equipment

THIS form of equipment can conveniently be divided into two main classes, one containing apparatus developed almost exclusively for routine testing of production items in factories and the other consists of apparatus for the servicing and maintenance of radio equipment in general. The former is very specialized and is often designed by individual firms for their particular needs, but there are certain commercial types of equipment that find application in this field.

Signal generators are perhaps one of the most important pieces of equipment in any receiver testing installation and as a consequence there has been much thought and work put into them Apart from calibration accuracy, which is an obviously essential feature, various ingenious means have been evolved to simplify interpreting the various scales on the instrument. The two principal ones are frequency and signal attenuation, subsidiary scales being modulation depth and a signal level monitor.

In the latest model produced by Marconi Instruments, the Type

Amplion Convette H.T. and L.T. unit for operating battery sets from A.C. mains.

TF867, the frequency scales occupy almost the whole of the front of the case. This generator

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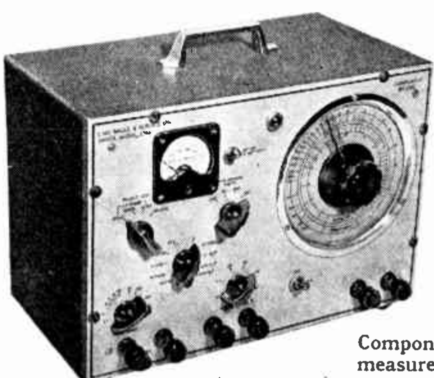
covers 15 kc/s to 30 Mc/s in eleven bands and can be modulated up to 100 per cent by an internal oscillator at either 400 c/s or 1,000 c/s, or external modulation can be applied. It includes a modulation meter, a crystal check oscillator giving beats at 1-Mc/s intervals throughout and an attenuator providing adjustment of the output from 0.4 μV to 4 V. The attenuator scale is calibrated in volts and in decibels; it has a traversing pointer.

Pye produce a range of signal generators which typify the present-day requirements for this class of equipment. There is one described as the "Workshop" model. It is mains operated and covers 140 kc/s to 50 Mc/s in seven ranges, with provision for internal modulation at 30 per cent. A calibrated attenuator adjusts the output in five steps between 1 μV and 0.1 V. There is a portable laboratory version of this model, mains operated, which covers 100 kc/s to 30 Mc/s in six bands and one designed especially for testing television sets. It covers 40 to 60 Mc/s and has two modulation signals applied to the carrier. These produce bars on the television screen for checking the frame and line time-bases. A 400-c/s modulation is also included for checking the sound channel. Price is £24.



Components bridge for measurement of inductance, resistance and capacitance, shown by E.M.I. Sales and Service.

Another reasonably priced signal generator, which has been designed largely to meet servicing requirements, is the E.M.I. (Sales and Service) all-wave oscillator. A useful feature is that it can quickly be adapted to either mains or battery operation by fitting the appropriate power pack, which is a separate unit contained in the base of the case. It has six ranges covering 90 kc/s to 32 Mc/s, a continuously variable attenuator plus an output switch giving a high-level R.F. output. Internal or external modulation can be applied. For mains operation it costs £26 5s.

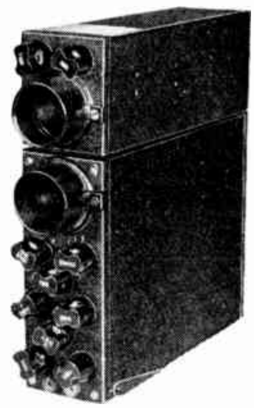
Other examples of signal generators were found among the AVO range of instruments, on the Taylor stand and among the Dawe instruments. The latter firm have produced a precision signal generator, Type 804A, covering 20 to 200 Mc/s with either F.M. or A.M. modulation. Standard Telephones also produce equipment of this kind for test rooms and servicing workshops.

Due to the vast strides made during the war years in the design of all classes of cathode-ray tube equipment the modern oscilloscope has become an extremely versatile and almost indispensable piece of test equipment.

A very elaborate waveform analyzer was shown by E.M.I. The latest Cossor oscilloscope, Model 1049, is a double-beam instrument fitted with D.C. amplifiers effective up to 100 kc/s and time-base control mechanism enabling any section of the trace to be opened out and examined in detail. A new feature is the inclusion of time-calibrated scales for the time-base giving measurements of waveform features in micro-seconds and milli-seconds and facilities for measuring the amplitude of the pattern in terms of voltage. This instrument is fitted with a flat-ended 4½in tube.

For those who want to build their own oscilloscope, or use a C.R.T. as part of an existing equipment already provided with suitable sweep circuits, Mullard have available a small unit, with self-contained power supply. It is listed as the Type B100. Accompanying this midget is a full-size double-beam oscilloscope, Type E805, designed for general waveform investigations. There was another double-beam instrument by Standard Telephones.

There were a number of single-beam oscilloscopes of the type used in test rooms for receiver alignment and general work of this kind. One of the most compact of these is the G.E.C. Miniscope, which was shown also by Salford Electrical Instruments. It has a 1½in tube, time-base covering 30 c/s to 80 kc/s, signal amplifier and power unit; it measures only 8¼in × 6⅝in × 2¼in. The most recent addition is provision for fitting another tube in a small housing on top of the instrument and taking all voltages from the main unit, thus converting it into a double-beam oscilloscope.



G.E.C. Miniscope showing second C.R. tube unit in position; this converts it for double-beam operation using the same time-base for both.

Another general-purpose type oscilloscope was seen on the E.M.I. (Sales and Service) stand. It is fitted with a 2½in tube, time-base for investigating waveforms from 15 c/s to 1 Mc/s in frequency, a push-pull signal amplifier and has provision for measuring A.C. and D.C. voltages and the voltage of any vertical part of the trace on a self-contained meter.

In this class of equipment is included the Taylor Model 30A oscilloscope which is fitted with a 3½in tube, time-base covering 10 c/s to 10 kc/s and a push-pull signal amplifier giving useful amplification up to 100 kc/s.

E.M.I. have also a number of

(*Continued on page 435*)

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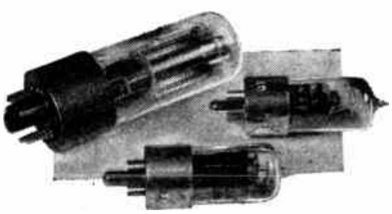
Show Review—
useful pieces of test gear for receiver and general servicing purposes, among which is a components bridge providing for measurements of inductance, resistance and capacitance.

The advent of so many new valve types has led to remodelling of the AVO Valve Characteristic Meter, which now caters for the latest miniature B8B and B8A based valves. This meter gives actual mutual conductance measurements on valves, measures grid current and enables amplification factor and anode A.C. resistance to be obtained. Comprehensive tests on the individual anodes in full-wave rectifying valves can be made. The meter embodies a very quick-acting over-load cut-out which prevents damage to any part of the equipment. Voltages and circuit arrangements for any valve are selected by a multiple-barrel selector switch.

Valves

ALTHOUGH all makers of valves were showing examples, and in some cases almost complete ranges, of the all-glass baseless style of construction, the current types on octal bases are likely to remain the mainstay for some time yet to come. There is nothing spectacular in the characteristics of the all-glass type, and their mutual conductances are very much the same as the equivalent pattern in current ranges. They are, however, more efficient at the television and the very high frequencies, since they are physically smaller and have much shorter internal connections to the pins and, of course, there is no base material, except glass, so that losses are kept down to a minimum.



Three of the latest Mazda valves, showing the types 10C1, 10P14 and 10LD11.

The all-glass valves exemplify the style of construction to be adopted by the industry for the proposed standardization scheme. The majority will have a small 8-pin base with their pins disposed around a circle of 11.5mm diameter. This is known as the B8A, and there is a centre spigot and a locating boss on the side of the base. A bayonet type valveholder is thus required.

Three of the latest Brimar valves, the 7H7 and 7Z4 on loctal bases and the 9D6 miniature R.F. pentode.

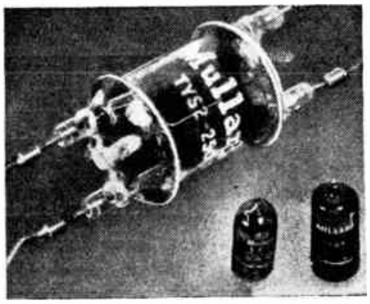
Output valves and those needing a large bulb are being fitted with a slightly larger version of this base, and it is now described as the B8B. This is similar to the 8-pin loctal base. There is also a button-type 7-pin base for the very small miniature valves, and this is known as the B7G.

The Brimar range of valves shown by Standard Telephones included a series described as loctal types fitting the B8B base and having a lock-in locating spigot carried on a false metal base. This has clearance holes through which the base pins project, the valve being an all-glass type. The series includes 1.4-volt battery valves taking 50 mA filament current as well as 6.3-volt mains types. In the latter type the 7H7 variable-mu R.F. pentode has a mutual conductance of 3.8 mA/V. In addition, Brimar now have a series of miniature types for the B7G holder for 1.4-volt and 6.3-volt operation.

Some A.C./D.C. valves consuming 100 mA of heater current and fitting the smaller B8A base are made by Mazda. These are identifiable by the serial number 10 with additional letters and figures according to the type and function of the valve. The 10F9, for example, is an indirectly heated R.F. pentode with a *g* of 2.4 mA/V and operating with 175 volts on the anode and 100 on the screen. The corresponding frequency changer is a triode-hexode with a conversion conductance of 0.65 mA/V and taking the same anode and screen voltages. The triode requires 80 volts at 4.5 mA. A D.D.-triode, output tetrode and half-wave mains rectifier are included. Mazda also had a few miniature types for the B7G base.

A short series of 8-pin all-glass valves, including a variable-mu R.F. pentode (W81), with a *g* of 2.8 mA/V, a D. D.-triode (DL82), output tetrode (KT81) and a triode-hexode frequency changer (X81M) are produced by G.E.C. These are 6.3 V types. There are also a few specimens of miniatures with the B7G base arrangement of pins, also for mains operation, one being the Z77 a high-slope R.F. pentode with a *g* of 7.5 mA/V developed especially for television receivers. Another special Osram type is the KT45, an output tetrode for the line scan time base. It operates at 4,000 volts on the anode and 300 on the screen.

Miniature all-glass valves shown by Mullard are mainly for use in industrial equipment. There were a few samples of the valves that will eventually be produced for domestic receivers, with the small B8A pin arrangement.



Mullard silica valve Type TYS2-250, and two of the new miniatures, EF42 and EF91.

Mullard were making a special display of industrial-type valves, among which were a range of silica transmitting triodes for use in radio heating equipment. These silica types can be run at very high temperatures, and generally require no assisted cooling. The smallest in the range, while not a large valve, will give an output of 720 watts R.F. at 50 Mc/s.

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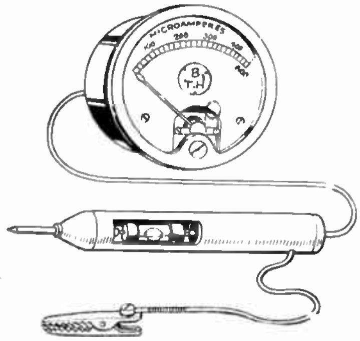
Another interesting Mullard development is an accelerometer valve giving an output proportional to acceleration. It has many applications in industrial electronics; one, for example, being the control of acceleration of lifts. Mullard is now producing a number of special V.H.F. transmitting valves of low and medium power for use in mobile and aircraft equipments. The QV04-7, QV05-25 (807 equivalent), QV04-20 (815 equivalent) and, most recent of all, the QV07-40 (829B equivalent) are types that will appeal also to amateur transmitters. The last two mentioned are double tetrodes in one envelope.

Comparable G.E.C. types are the TT11, a single R.F. tetrode, and the TT15, a double assembly suitable for use up to at least 100 Mc/s in small transmitters.

Some of the latest types of Osram valves showing the DET22 grounded grid triode, TT15 double R.F. tetrode and DH81.

For centimetre operation in radar equipments G.E.C. were showing some grounded-grid triodes in the form of the DET22, for use down to 10-cm wavelength and the ACT22 and ACT23, which are used in the London-Birmingham experimental television link system on centimetre wavelengths.

During the war enclosed crystal rectifiers were developed for use in the centimetre radar equipments. Their construction has been described in this journal. These stable silicon crystal rectifiers were shown at this exhibition by B.T.-H., together with a more robust variety which has been developed for use in television sets, test and servicing equipments requiring a diode-type rectifier capable of functioning efficiently up to about 100 Mc/s. The fact that it needs no filament supply is an added attraction for test gear purposes. Described as the B.T.-H. Germanium crystal rectifier, it will pass a continuous crystal current of 50 mA D.C. The rectifier is comparable in size to



The miniature B.T.-H. Germanium crystal rectifier mounted in a small probe.

a ¼-W resistor and has similar end connecting wires.

Cathode ray tubes for television use vary in size from about 9in to 15in diameter. They are now almost exclusively focused and deflected by magnetic means, the electrostatic principle being confined to the instrument types.

A new development included in the latest 10-in and 15-in Cossor tubes, the types 75K and 85K respectively, is an ion trap to prevent "blackening" of the centre of the screen after a period of use. In these tubes the beam is intentionally off-set and is centred by means of a small permanent magnet applied to the neck of the tube near the gun. Focusing is effected by another permanent magnet located in the usual position just behind the deflection coils. For fine adjustment of the focusing Cossor arrange to vary the final anode volts. This beam control system is effective on the electrons only, and any heavier ions which normally would impinge on the centre of the screen are virtually unaffected, and so find their way harmlessly to one side of the screen.

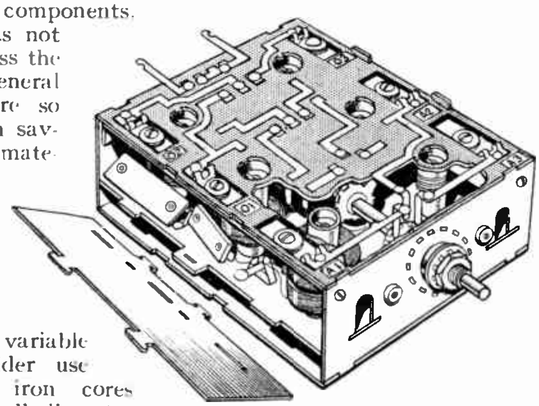
Cossor were showing a new 4½-in tube with a perfectly flat end for use in oscilloscopes to facilitate making measurements on the end of the tube. Flat screen tubes were shown by G.E.C. in types suitable for television receivers.

Components and Accessories

WHEN examining the products of the component makers at the Exhibition one could not but be impressed by the excellent workmanship put into this class of article. This is not all external effect, for where stripped models are shown the same fine finish was seen.

Development work during the war years was intensely concentrated on the design and production of miniature components, and as efficiency has not suffered in the process the advantages of this general reduction in size are so obvious, not only in saving space but also in material, that their numbers will increase rather than decrease.

Items that might have suffered in this miniaturization process are tuning coils of all kinds and variable condensers. The wider use of improved dust iron cores and coils of very small diameter have enabled the size of the screening can to be reduced, in some cases to less than one inch square, without any corresponding reduction in efficiency. Examples of these coils are the Wearite type M400B midget I.F. transformers assembled in cans measuring $1\frac{3}{16}$in high and $\frac{13}{16}$in square. They are now available for intermediate frequencies of 460 kc/s, 1,600 kc/s, 2.1 Mc/s, and 4.86 Mc/s. In all cases the "Q" of the circuit is of the order



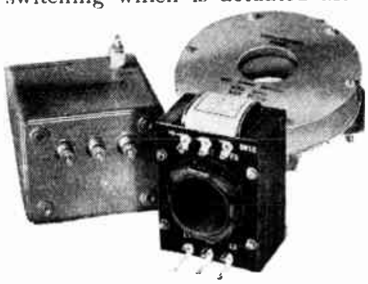
New Wearite 3-range coil unit with pre-formed strip wiring and wave-change switches built-in.

of 100. They are permeability trimmed.

Midget coils in cans of 1in square were seen also on the Weymouth stand. There are signal tuning coils as well as I.F.s, and they are described as "K" coils. They are permeability trimmed and their "Q" is of the order of 120.

Permeability tuners are not new; many will recall the early specimens of some years before the war. Now, with present-day knowledge in miniaturization such units can be built in very compact form. One made by Electrical and Radiological Instruments is designed to cover one band only. Separate units, including scale and pointer, are used for each waveband it is required to cover.

The Weymouth permeability tuner contains four coils with a carriage carrying four long thin dust iron cores which are moved in and out of the coils by a large eccentric cam, the spindle of which is the tuning control. A novel feature of this unit is the inclusion of automatic waveband switching which is actuated after

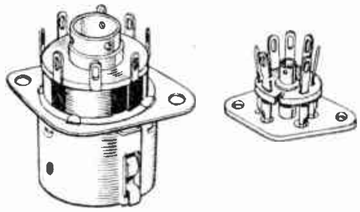


Haynes focus and scanning coil assemblies together with line output transformer.

the first 180-degree rotation of the control. The second 180-degree rotation thus tunes over the other waveband. A 360-degree scale is used.

Air-cored coils for broadcast receivers are still available in fair numbers, examples being found on the stands of R.M. Electric, Weymouth and Wright and Weaire, while short-wave coils made of silver-plated copper wire are obtainable from Q-Max and Eddystone. Both these firms cater for the radio amateur and some fine examples of turret coil units, special transmitting type variable condensers and the many kinds of small and large insulators in ceramic and polythene - based materials are produced.

Split-stator and other varieties of variable condensers for use in transmitters and radio-heating equipment were shown by Sydney S. Bird and fixed capacitors for the same applications, some capable of carrying several amperes of R.F. current at high frequencies, are included among the products of Dubilier, United Insulators and T.C.C. Polar and Plessey were showing some fine examples of miniature gang condensers for broadcast receivers and miniature portables.

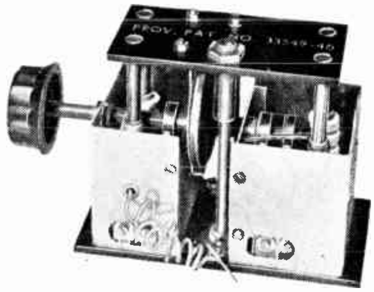


Clix B8A and B7G valveholders.

Some of the very special television components are now becoming available, although only two firms were actually showing them. Plessey had a full set of these parts comprising line and frame transformers, blocking oscillator coils, type LS for line and FS for frame and focus coils; type A1, of 500 ohms carrying 100 mA and another type A2 of 100 ohms to carry 200 mA. Low-impedance scanning coil assemblies for 9in tubes are also included.

Further examples of television components were seen on Haynes Radio stand, where were shown E.H.T. transformers in copper containers with ceramic bushes for the high-voltage output. In the Haynes scanning coils a high-impedance frame winding is used with a low-impedance line winding. This, and the accompanying focus coils, are designed for tubes with 35 mm diameter necks.

Haynes also have some small threaded coil formers, 32 t.p.i. fitted with adjustable iron dust cores for winding television sound and vision signal tuning coils. Other television components seen were a series of co-axial plugs and sockets for aerial feeder cables made by Belling and Lee. Among these is a very useful extension connector, described as the type L616 coupler, for extending a co-axial feeder. The L619 cable plug is a new edition and it accommo-

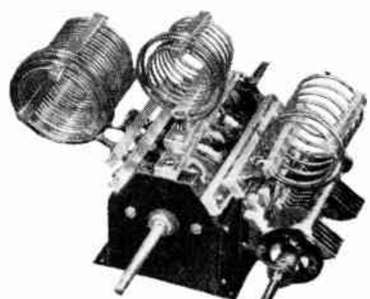


Weymouth permeability tuning unit.

dates cables of about ⅜in outside diameter. There is also a connector with an external locking ring, the L1249 plug and L1267 chassis socket, designed to have a very low contact resistance. Cable sockets and chassis plugs of the same design are also included.

The new valves with B8A, B8B and B7G bases require special valveholders and these are now being produced by British Mechanical Productions (Clix) and Belling and Lee.

Some new cartridge-type fuses were seen on Bulgin's stand in which the fusing current for the different sizes increases by a factor of 1.5. Another innovation adopted by this firm is the grading of their potentiometer values in accordance with the 20-per cent tolerance preferred numbers scale.



Q-Max P.A. coil turret for amateur transmitters. It covers the 3.5-, 7-, 14- and 28-Mc/s bands.

Battery eliminators, once very plentiful but rarely seen in the past decade, appear to be coming into favour again. Amplion have two models, one for replacing the batteries in all-dry type sets, fitted with 1.4-volt valves, the other for sets with 2-volt valves using an L.T. accumulator. These units

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provide both L.T. and H.T. current and are not merely an H.T. eliminator plus trickle charger for L.T. accumulators. They are described as Convette units.

Among the many accessories at the Show were several of more than usual interest, although of very widely different application. One was a time switch for switching on and off the radio set, at pre-determined times throughout the day. It is known as the Rototime Programme Selector and can also be used to operate an electric fire, kettle, light, etc., as it will handle up to 10 amps at 250 volts. Another item, which is of particular interest to short-wave listeners, is the Haynes Undulator, more simply but less accurately described as a morse inker. It records morse signals on a paper tape and can be used with any communications receiver. It contains the necessary rectifier as well as all noise suppressors. Morse is recorded by a continuously writing stylus with the characters formed above a datum line, hence the description "Undulator." It is a practical instrument capable of recording high-speed telegraphy and the price is £25.

Electronics

AMONG applications of thermionic valves which are not radio and have come to be termed electronics, R.F. heaters for dielectrics and the heat-treatment of metals are probably the most important.

British Insulated Callender's Cables were demonstrating a range of R.F. heaters which included soldering equipment for use in connection with silvered glass and ceramic components, and a seam welder for thermoplastic sheet. Murphy Radio also had a seam welder on show.

The range of R.F. heaters shown by Electrical & Musical Industries included a 1 kW 1 Mc/s unit (Type RFH/1) which was shown in operation for cementing loudspeaker cones. At the other end of the range, the Type RFH/4, with separate air-blast cooled oven unit, is rated at 4 kW, and uses a single air-cooled oscillator valve. The frequency range is from 20 to 40 Mc/s.

On the G.E.C. stand, the 5 kW industrial R.F. generator was shown in operation for the rapid brazing of tungsten carbide tips on machine cutting tools.

An 800-watt R.F. heater capable of pre-heating half a pound of bakelite powder in one minute was shown by Metropolitan Vickers. The built-in electronic timer switches off and opens the heating chamber automatically at the end of the process cycle. The general proportions of the heater are tall and narrow, for convenient installation between presses.

The Type F12/1 R.F. generator made by Philips Industrial is rated at 12 kVA (5 kVA in work), and is designed for heat-treatment of metals. The frequency is 800 kc/s. In the Type FV/100 (50 kVA in work) a choice of four frequencies between 350 kc/s and 1 Mc/s is available, and the equipment is applicable to sintering and melting as well as heat-treatment.

The Type 6/10 heater, rated at 6½ kW (1 Mc/s) was shown by by Pye and, Standard Telephones and Cables were showing their Type 4M for induction heating giving up to 4 kW at 400 kc/s.

Medical applications of R.F. heating (short-wave therapy) were demonstrated by Philips, and Ediswan were operating their electro-encephalograph for recording brain potentials.

The measurement of moisture content of grain and electrical titration end point indicators were shown by Mullard.

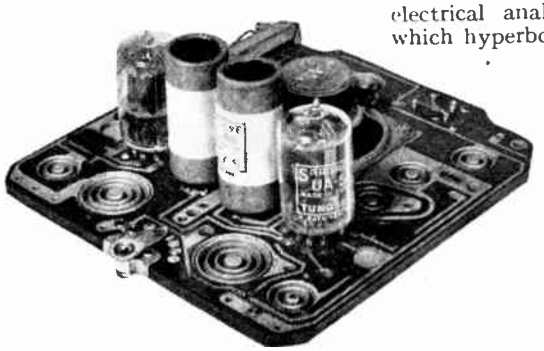
Electronic methods of motor speed control were shown by Metropolitan Vickers, and B.T.-H. were demonstrating a remote position control system in which alignment error signals are amplified and used to control an amplidyne generator system. Feedback is included to prevent hunting in the rotary machines.

The yarn breakage detector shown by Ferranti was also in the electronics section. This has been evolved to detect the failure of single yarns in textile weaving machinery. A steel wire, stretched at right angles to the run of the yarns and immediately below them, is anchored at one end to a "bender" type piezo crystal. If a yarn breaks and brushes against the wire a voltage is induced in the crystal pick-up which is amplified and used to operate indicator lamps. Normal machine vibration does not operate the device which is tuned to a supersonic frequency.

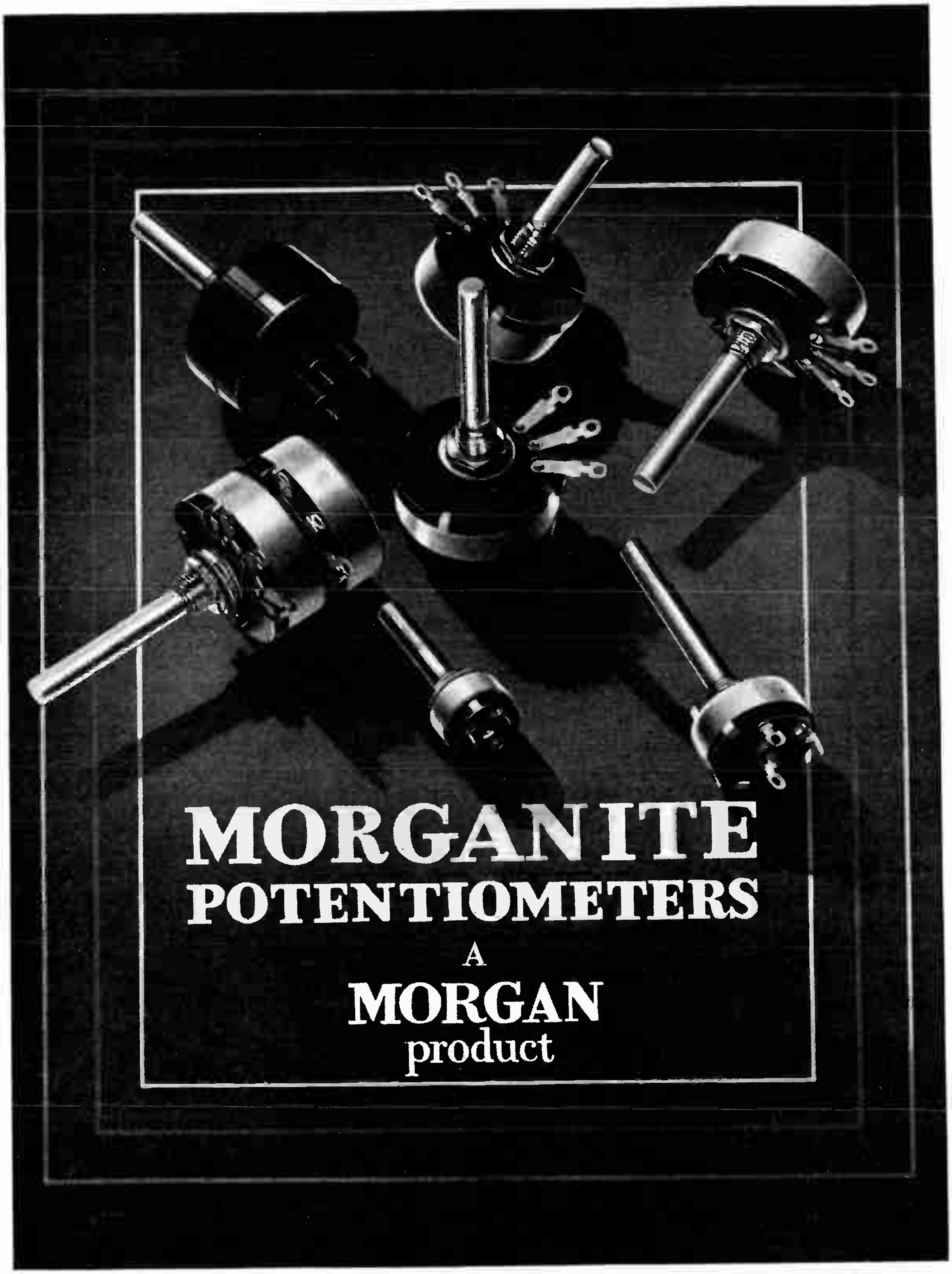
Radar navigational equipment based on the specification recommended by the Ministry of Transport was shown by Cossor, Metropolitan Vickers and Marconi. Although the basic performance is similar, there has been ample scope for individuality in engineering, and ship owners will have variety of choice not only in chart-room display layouts, but in the method of sectionalizing and installing the remainder of the equipment.

Information on aids to navigation—"Gee," "Decca," and "Consol" was available on the stands of Cossor, Decca and Marconi's W.T., and Ferranti were showing an extremely compact hyperbolic computor suitable for use with "Gee," "Decca," or "Loran." Essentially it is an electrical analogue computor in which hyperbolic co-ordinates are translated directly into courses to steer and distances to be made good, without reference to special maps.

A beautiful example of lightweight aircraft radio construction was to be seen in the "Rebecca" beam approach system shown by E.M.I. Spot frequencies are provided for all the principal British and American homing systems.



SARGROVE all-stage valves, shown by Tungsram, fitted on a chassis with components "sprayed on" by the E.C.M.E. process.



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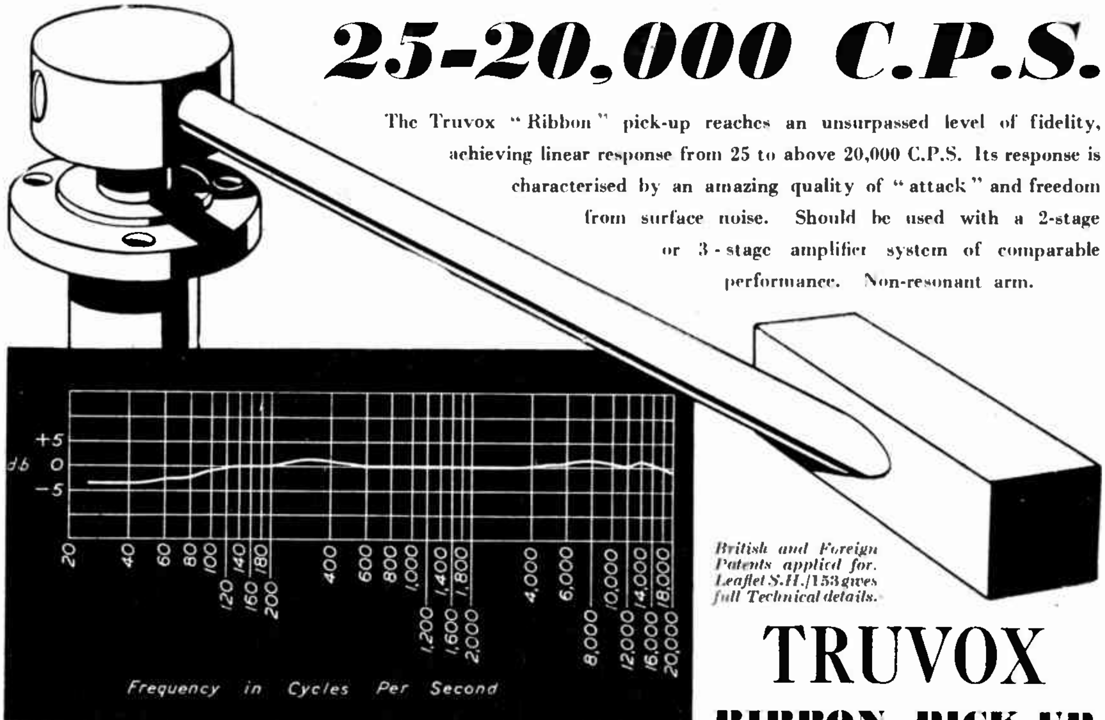

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INTERNATIONAL FREQUENCY ALLOCATIONS

ALTHOUGH the meetings of the International Telecommunications Conference at Atlantic City have now ended, final details of the agreements, as signed by the plenipotentiaries, are not available at the time of going to press.

However, thanks to John Clarricoats, an R.S.G.B. delegate to the Conference, we have had an opportunity of seeing the official list of frequency allocations in its penultimate form. Except, perhaps, for very minor changes this is the plan on which frequencies for all radio services throughout the world will be based as soon as it has been ratified by the 75 participating countries.

For the purpose of this brief summary of significant changes in frequency allocations we are confining ourselves to those directly affecting the "European" Region, which, it should be pointed out, now includes the whole of Africa, the Atlantic islands, etc.

M.W. Broadcasting. The medium-wave band has been increased from 550-1,500 kc/s to 525-1,605 kc/s.

"Tropical" Broadcasting bands have not been increased, although their positions have been changed slightly. They are now 2.3-2.498, 3.2-3.4 and 3.95-4.0 Mc/s. These bands are shared with fixed and mobile stations (excluding aircraft).

S.W. Broadcasting. There have been a number of changes in the allocations for broadcastinig below 65 metres and most of the existing bands have been extended. They are to be: 4.75-5.06 (shared with fixed and mobile stations), 5.95-6.2, 7.1-7.3 (the first 50 kc/s in this band is shared with amateurs), 9.5-9.775, 11.7-11.975, 15.1-15.45, 17.7-17.9, 21.45-21.75 and 25.6-26.1 Mc/s.

V.S.W. Broadcasting and Television. Above 40 Mc/s broadcasting has been allocated the following bands: 41-68, 87.5-100 (in the U.K. fixed and land mobile stations may use 95-100 Mc/s), 174-216, 470-585, 610-960 Mc/s.

Amateurs. In the band 1.715-2.0 Mc/s amateurs in eight countries (including the U.K.) in the European Region may be assigned a band of 200 kc/s wide. The 3.5-3.8-Mc/s band is shared with fixed and mobile stations. Amateurs throughout the world have the exclusive use of 7.0-7.1 Mc/s and in the European Region share 7.1-7.15 Mc/s with broadcasting. The other bands allocated exclusively to amateurs are: 14-14.35, 21-21.45, 28-29.7 144-146, 1,215-1,300, 2,300-2,450, 5,650-5,850 and 10,000-10,500 Mc/s—there have been no allocations above this frequency. In addition to the above, amateurs have been allocated 420-460 Mc/s, which they will share with aeronautical navigational aids, with a proviso that no interference is caused with the latter. It will be noticed that the amateurs have lost their 5-metre band, but it is possible that it may be allocated later for internal use. The 7, 14 and 28-Mc/s bands have been pruned of some 500 kc/s, but they have been given a new band of 450 kc/s at 21 Mc/s and the additional high-frequency bands listed above.

Standard Frequency transmissions have been allocated the following bands: 2.498-2.502, 4.995-5.005, 9.995-10.005, 14.990-15.010, 19.990-20.010 and 24.990-25.010 Mc/s.

Radar. For the first time radar features in the list of international allocations. In some of the bands proposed for radio navigation, merchant-ship radar has been allocated the following sections: 3,000-3,246, 5,460-5,650 and 9,320-9,500 Mc/s. Surveillance radar may be operated in the 1,300-1,365-Mc/s section of a band allocated to fixed and mobile stations.

Industrial, scientific and medical equipment is now assigned specific frequencies in the spectrum. They are: 13.56, 27.12, 40.68 and 5.85 Mc/s.

Aeronautical services occupy a very considerable number of bands. Navigational radio aids for aircraft have been allocated some thirteen bands above 30 Mc/s.

One of the important outcomes of the Alantic City conference, so far as frequency allocations are concerned, is the decision to set up an International Frequency Registration Board whose task it will be to consider all future assignments. The work of preparing the present table of allocations—covering all frequencies between 10 kc/s and 10,500 Mc/s—was undertaken by a sub-committee of five delegates. Two of the members were U.K. delegates—Sir Stanley Angwin, chairman, and A. H. Mumford The other countries represented on the committee were France, U.S.A. and U.S.S.R.

STANDARD FREQUENCY TRANSMISSIONS

IN order to facilitate comparisons between the quartz frequency standards at the Royal Observatory establishments at Greenwich and Abinger, and also with similar standards at the Post Office Radio Branch Laboratories and the B.B.C. receiving station at Tatsfield, an experimental standard frequency transmission has been in operation each week-day from the observatory's radio station at Abinger, Surrey, since October, 1945.

Many Government and commer

OUR COVER illustration shows the reflectors on a model of the towers for relaying television to the Midland transmitter at Sutton Coldfield. A model of a complete G.E.C. link station is shown here.

World of Wireless—

cial establishments have found the transmission convenient for the checking of local frequency standards and we have been asked by the Astronomer Royal to draw attention to the transmission in case other laboratories may wish to make use of it.

The transmitter operates on a nominal frequency of 2 Mc/s, which is derived from one of the primary standards. No attempt is made to adjust the frequency to the exact nominal value, but by selection of the controlling oscillator, the transmitted frequency is usually within one part in 10^7 of the allocated frequency.

The normal daily programme commences with a voice announcement of the call-sign (GMT) between 09.58 and 10.00 G.M.T. From 10.00 to 10.15 the carrier is radiated unmodulated, and from 10.15 to 10.25 a 1,000-c/s modulation is applied. A final voice announcement is made between 10.25 and 10.30 and the provisional correction to the transmitted frequency is announced in parts in 10^8. These provisional corrections are normally accurate to about ± 2 parts.

The station is located on the north side of Leith Hill, in Surrey, and operates on a power of approximately 350 watts. Prospective users are invited to write to the Observatory, and they will then be informed of any changes in the schedule. Correspondence should be addressed to: Astronomer Royal, Royal Observatory (Greenwich), Abinger Common, near Dorking, Surrey.

AMATEUR EXHIBITION

As announced recently the R.S.G.B. is organizing an amateur radio exhibition which will be opened by Col. Sir Stanley Angwin, chairman of Cable & Wireless, on November 19th at the Royal Hotel, Woburn Place, London, W.C.1. It closes on Saturday, November 22nd.

Admission to the exhibition will be by catalogue, price 1s at the show, or 1s 3d by post from the Society. The hours of opening are 2 p.m. on the first day and 11 a.m. on subsequent days. The show will close daily at 10 p.m. (Sat. 8 p.m.).

Manufacturers and suppliers of equipment for amateurs who will be exhibiting are: Antiference, Belling-Lee, Denco, E.M.I., Labgear, Mullard, Measuring Instruments (Pullin), Odeon Radio, Radiocraft, Raymart, Southern Radio & Electrical Supplies, Stratton, Taylor Electrical Instruments, T.C.M. Co., and Woden Transformers.

TECHNICAL APPRENTICES

Some of the one hundred and sixty boys and girls between 16 and 18 years of age, who are required by the Ministry of Supply, under the Government apprenticeship scheme will fill vacancies at the Telecommunications Research Establishment and Radar Research and Development Establishment, Malvern.

An open competitive examination will be held on February 5th and 6th, 1948, in most of the principal towns of the U.K. Successful candidates will undergo five years' practical training and will have facilities for technical and further general education at full pay—from 29s a week at 16 to 67s 6d at 20. Apprentices who have to live away from home will receive a special maintenance allowance.

Details of the examination are available from the Secretary, Civil Service Commission, Burlington Gardens, London, W.1. The closing date for entries is December 1.

RESEARCH

A programme of research into the industrial applications of electronics is to be undertaken by the Telecommunications Research Establishment at Malvern on behalf of the Department of Scientific and Industrial Research. It is also proposed that the D.S.I.R. assumes responsibility for the work on fundamental radio research at T.R.E.

These proposals were put forward by Sir Edward Appleton, Secretary of D.S.I.R., to the Select Committee on Estimates. The cost of the research is £140,000 a year.

EUROPEAN RADIO UNITY

It is learned from the *I.B.O. Bulletin* that after the admission of the International Broadcasting Union as an observer at the Atlantic City Conference (referred to in our last issue) M. Julien Kuypers, president of the International Broadcasting Organization, spoke of Europe's need of radio unity.

Stating that the I.B.O. has 28 active members, he added: "It has its headquarters and control centre in *Western Europe*. . . It includes all the *Slav nations*, the spiritual power of the *Vatican*, and *Egypt*, the heart and brain of the *Arab* world. Only the B.B.C., certain Scandinavian countries, Switzerland, Portugal, etc., are missing."

PERSONALITIES

W. S. Barrell, director and superintendent engineer of E.M.I. Studios, Ltd., and **M. J. L. Pulling,** M.A., superintendent engineer (recording) of B.B.C., have been elected vice-presidents of the British Sound Recording Association.

F. S. Barton, M.A., B.Sc., director communications development, Ministry of Supply, has been decorated with the American Medal of Freedom with Silver Palm. He joined the Royal Aircraft Establishment on the formation of the radio department in 1922, of which he was deputy head from 1936-1941. He was director of radio engineering to the British Air Commission, Washington, from 1941-1946.

Frank Tomlinson has resigned from Whiteley Electrical Radio Co. where he was Sales Manager. He was with S.T.C. for 18 years before being seconded to the Ministry of Aircraft Production in 1940, where he was director of radio production from 1942 to 1945. He joined Whiteleys in 1945.

P. G. A. H. Voigt has, we regret to record, undergone an operation and his complete recovery is expected to take about three months.

IN BRIEF

Long-distance F.M.—Reception in Australia of F.M. transmissions from the United States at fairly regular intervals during the early part of the year is announced by the Australian News and Information Bureau. Of the 150 stations logged on frequencies between 30 and 40 Mc/s about a third have been F.M. transmissions.

Licences.—The latest figures (August) show that of the 10,890,540 broadcast receiving licences in force in Great Britain and Northern Ireland 23,150 were for television receivers.

Royal Signals.—A London Branch of the Royal Signals Old Comrades' Association has now been formed with headquarters at 206, Brompton Road. Membership is open to all ex-members of the Corps or of its predecessor, the Signals Service (R.E.), and to N.C.O.s and men of the Indian Signal Corps. Women who served in the A.T.S. in any Royal Signals trade are also eligible. The honorary secretary is J. Boyd, 10, Cyprus Road, London, N.3.

Edison Museum.—A "Thomas A. Edison Museum of Industry" is to be opened in San Francisco and certain items, particularly early telephone equipment, which are believed to be in this country, are needed. Offers of suitable equipment or correspondence sent, stating price, to Edison Museum, c/o the Editor will be forwarded.

Electrical Engineering Courses arranged by the L.C.C. South-East London Technical Institute, Lewisham Way, S.E.4, include a post-graduate course of 30 lectures on communication networks by W. Saraga, Ph.D., and short courses on electronics and radio-frequency measurements. Applications for admission to the courses, which begin this month, should be made to the head of the Electrical Engineering Department. Short courses on television and the applications of the C.R.T. to mechanical and electrical engineering are planned for January.

Manchester Courses.—Twelve lectures on recent developments in electronics will be given at the College of Technology, Manchester, on alternate Wednesdays, from 7-9 p.m., commencing on November 5th. The fee will be £1 11s 6d.

"Sound Recording" is the title of the new printed journal of the British Sound Recording Association, the first copy of which was published in September.

INDUSTRIAL NEWS

Decca.—A Danish subsidiary of Decca, to be known as Dansk Decca Navigator Company, Ltd., has been formed to complete the construction of the Danish chain of stations, now being built, and to operate them when brought into service early next year.

McMichael Radio recently made use of Cable and Wireless photo-telegraphy service to transmit pictures of their latest export receivers to agents in Bombay, Cairo, Malta, Cape Town, New York and Montreal. Technical details were telegraphed.

To Exporters.—We have had a touching appeal from Som Datt, of the British Radio and General Supply Company, formerly in Lahore, Pakistan. He has been forced to flee into India, and asks that British shippers of radio goods to him should immediately divert them to his present address: care L. Jowinda Mal, Kutcha Badhar Kali, Bazar Kalan, Jullander City, India.

Instanta Electric, Ltd., manufacturers of Instanta relays, have been acquired by Magnetic Controls, Ltd., 48, Old Church Street, Chelsea, London, S.W.3 (Tel.: Flaxman 8342).

Zirconal, Ltd., has been formed in conjunction with Silicon (Organic) Developments, Ltd., 11, Cavendish Place, London, W.1, as a production unit for the manufacture of synthetic Mullite and Zircon refractory compounds, using the Silester bonding process.

J.D. Radio, Ltd., manufacturers of receivers and components for export, have moved from Maida Vale to 12, Pembroke Street, Copenhagen Street, London, N.1 (Tel.: Terminus 4355).

CLUBS

Barnet.—The next meeting of the Barnet and District Group of R.S.G.B. will be held at the Millicent Café, Lytton Road, New Barnet, on November 15th at 7.30 p.m. Non-members are welcome at all meetings of the group. Sec.: R. Walker, G6QI, 7, Potters Lane, New Barnet, Herts.

Bradford.—At the conclusion of its first year's operation the Bradford Amateur Radio Society has 59 members, of which 30 are licensed amateurs. Sir Edward Appleton has resigned the presidency. Meetings are held on alternate Tuesdays at 7.30 at 66, Horton Lane, Bradford. Sec.: W. S. Sykes, G2DJS, 287, Poplar Grove, Gt Horton, Bradford, Yorks.

Leicester.—The next meeting of the Leicester Radio Society on October 28th will be addressed by H. Fairhurst, of Murphy, who will describe the company's V114 television receiver. "Radio Valve Manufacture" is the title of a lecture to be given by P. I. Nicholson, of Ediswan, on November 4th. Both meetings begin at 7.30 at the Charles Street United Baptist Church. Sec.: O. D. Knight, 16, Berners Street, Leicester.

MEETINGS

Institution of Electrical Engineers

Ordinary Meetings.—Report on "The Practical Training of Professional Electrical Engineers" presented by Sir Arthur Fleming, C.B.E., D.Eng., on November 20th.

Radio Section.—"Tests for the Selection of Components for Broadcast Receivers," by G. D. Reynolds, Ph.D., M.Sc., on November 5th.

Discussion on "What Equipment is necessary for the Servicing and Testing of Electronic Devices" to be opened by Wing Cdr. P. Allerston, O.B.E., on November 11th.

"The Cavity Magnetron," by H. A. H. Boot, Ph.D., and Prof. J. T. Randall, D.Sc.; "The High-Power Pulsed Magnetron—Development and Design for Radar Applications," by W. E. Willshaw, M.B.E., M.Sc.Tech., L. Rushforth, B.Sc., A. G. Stainsby, B.Sc., R. Latham, M.A., A. W. Balls, B.Sc., and A. H. King, M.A.; and "The High-Power Pulsed Magnetron—a Review of Early Developments," by E. C. S. Megaw, M.B.E., D.Sc., on November 19th.

All the above meetings will begin at 5.30 at the I.E.E., Savoy Place, London, W.C.2.

Cambridge Radio Group.—"Pulse Communication," by D. Cooke, A. J. Oxford, Z. Jelonek, and E. Fitch, on November 11th at 8.15 at the Cavendish Laboratory.

North-Eastern Radio and Measurements Group.—"The Application of Electrical Technique to the Service of Some Other Industries," by H. Cobden Turner, J.P., and G. M. Tomlin, on November 3rd.

Addresses by the Chairmen of the Radio and Measurements Sections on November 17th.

Both meetings will begin at 6.15 at King's College, Newcastle-on-Tyne.

North-Western Radio Group.—"Trends in Television Receiver Design," informal lecture by N. H. Searby, Ph.D., on November 19th at 6.30 at the Engineers' Club, Albert Square, Manchester.

South-Midland Radio Group.—"The Wartime Activities of the Engineering Division of the B.B.C.," by H. Bishop, C.B.E., B.Sc.(Eng.), on November 24th at 7 at the James-Watt Memorial Institute, Great Charles Street, Birmingham.

Southern Centre.—"The Design of High Fidelity Disc Recording Equipment," by H. Davies, M.Eng., on November 20th at 5.45 at the Admiralty Signal Establishment, Haslemere.

Royal Society of Arts

"The Development of Sound Recording and Reproduction," by Sir Ernest Fisk, on November 19th, at 2.30, at the Royal Society of Arts, John Adam Street, London, W.C.2.

Institute of Physics

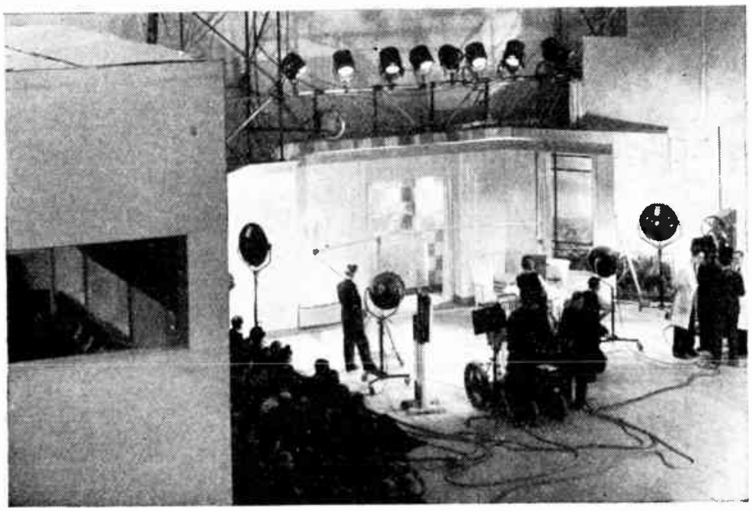
Electronics Group.—"Infra-Red Image Converters," by J. H. Pratt, on November 4th at 5.30 in the rooms of the Royal Society, Burlington House, Piccadilly, London, W.1.

British Sound Recording Association

"What is High-Quality Reproduction?" Discussion to be opened by M. G. Scroggie, B.Sc., on November 21st at 7.0 at the Royal Society of Arts, Adelphi, London, W.C.2.

British Interplanetary Society

"Electronics and Space Flight," by Arthur C. Clarke, on November 8th at 6.30 at St. Martin's Technical School, Charing Cross Road, London, W.C.2.



RADIOLYMPIA. A corner of the television studio at the exhibition. When the ten-day show closed on October 11th, 443,433 people had attended. The previous record was 238,285 in 1934. The record daily attendance for any Olympia exhibition was exceeded on the fourth day.

Tuning Circuits—Obvious and Otherwise

The Rôle of Invisible Components

By "CATHODE RAY"

WIRELESS enthusiasts of the older school, such as "Free Grid," no doubt well remember the fever of anticipation which was built up by long-drawn-out publicity in the interests of a certain receiver circuit. When ultimately released, almost every detail of the new circuit appeared truly revolutionary. If I remember rightly, the L.T. battery was in series with the aerial. Yet when students of technique, wishing to sift the mystery to its dregs, redrew this circuit in more conventional layout, they discovered that it was really a very ordinary and familiar one indeed; the equivalent in those days of the present stereotyped four-plus-one.

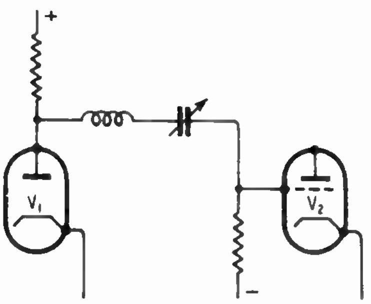


Fig. 1. This looks an abnormal type of tuned coupling, but in a V.H.F. amplifier it is not essentially different from the familiar transformer-tuned circuit.

It just shows how right Bainbridge-Bell is to insist on the importance of adhering to a standard way of drawing circuit diagrams; a way devised to make it as easy as possible to see what they are and how they work. However, I am not plugging that particular piece of propaganda to-day, but, assuming the action of a circuit is more easily seen when it can be identified as belonging to a familiar type, I want to pull the masks from the faces of certain diagrams that may go unrecognized through no fault of their own. I mean those used for very high frequencies, in which the visible components do not tell the whole story. Fig. 1, for example, may look a very odd and unconventional sort of tuned R.F. coupling to find between a pair of valves; apparently an acceptor circuit in place of the usual rejector circuit. How, then, does it work?

The clue lies in the fact that at such frequencies—100-300 Mc/s, say—the impedances of the valve electrodes are not only not negligible but are quite as important as the external impedances provided by the visible components. In fact, in the limit most of those components may entirely vanish.

At low frequencies, the input impedance of a negatively biased valve consists of an almost infinite resistance (many megohms, at least) in parallel with a few pF (=μμF)—a small "stray" capacitance, which can be allowed for by making the intentional tuning capacitance just a little less than it would otherwise be. The output impedance, looking back into the anode, consists of a similar or slightly smaller stray capacitance in parallel with the anode resistance, r_a, which in some types of R.F. pentode may reach a value as high as a megohm or two.

To tune to the highest possible frequencies, we reduce the intentional tuning capacitance until finally there is none of it, whereupon the "strays" assume the entire rôle. At the same time we reduce the tuning inductance, until the inductances of the valve electrodes and leads (which we hadn't noticed at all at the lower frequencies) set a limit to the process. By that time the frequency is so high that strange things are happening in the inner workings. The cathode inductance introduces a feedback effect which is equivalent to shunting a comparatively low resistance across the input. And the transit-time effect—due to the fact that the time taken for the electrons to cross the valve is an appreciable part of one V.H.F. cycle—has a similar result. So the input resistance, instead of being much greater than the output resistance, is far less, and may, perhaps, amount

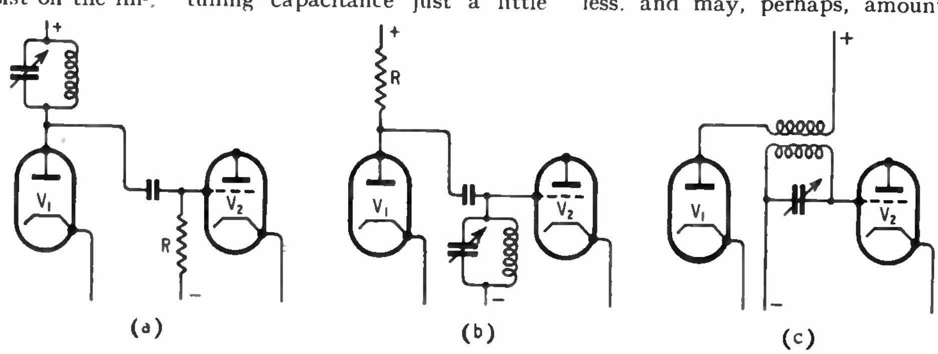


Fig. 2. Three varieties of the common tuned R.F. amplifier coupling.

to only a few hundred ohms.

The best-known varieties of conventional tuned amplifier couplings are shown in Fig. 2, where the only difference between (*a*) and (*b*) is the method by which the anode and grid are supplied with the necessarily different working voltages. These voltages are separated by a blocking capacitor, which nevertheless is a path of negligible impedance to signal currents, so it doesn't matter very much which side the tuned circuit is connected. But whichever electrode is not connected to its working potential *via* the tuned circuit must be connected *via* an impedance, R, which is high to signal currents, and may be a resistor or choke. In (*c*) the coupling is inductive, so no blocking capacitor is required; and as there are two windings there is no need for any other D.C. path. Either primary or secondary or both may be tuned.

If one wants to be very precise, one can draw dotted capacitors across primary and secondary to represent the valve "strays," and a dotted resistor across the primary to represent the output impedance of V1. In (*a*) and (*b*) (and in (*c*), too, if the transformer is 1 : 1 ratio and closely coupled), all these are effectively in parallel with one another, because + and — H.T. are both earthed so far as R.F. is concerned. At low-frequency R.F., however, the shunting effect of the valve resistance is almost negligible in comparison with the dynamic resistance of the tuned circuit itself.

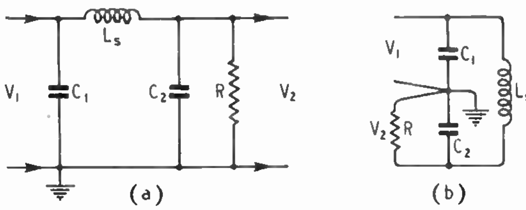


Fig. 4. Two alternative ways of drawing the equivalent tuning circuit of Fig. 3 if C and L are omitted. Assuming (as in practice one generally can) that R is much greater than the reactances, this coupling is a transformer with a $C_2 : C_1$ ratio.

Now suppose the frequency is raised to the hundred-megacycle order, so that the extra valve effects become really important. Fig. 2(*b*) becomes Fig. 3, which looks a good deal more complicated. But remembering that the negative ends are all at R.F. earth potential, as shown dotted, it is not very difficult to identify as a loose-coupled circuit, tuned by the valve capacitances. The original tank circuit, LC, is now merely the coupling impedance. The smaller L is made, with the object of raising the frequency to its limit, the looser the coupling and the less the effect of C. The primary and secondary tuning is outside our control (except by choosing valves on an internal capacitance basis). And so very largely is the transformer ratio. Actually one wants a step-down to match the low input resistance of V2.

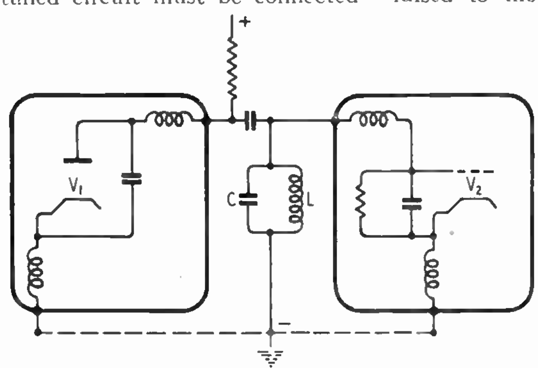


Fig. 3. What Fig. 2*b* looks like if the valve characteristics that are important at V.H F. are shown.

Fig. 3, then, doesn't look like being a very satisfactory circuit for the highest attainable frequencies. Certain valves, such as the EF54, are designed for low internal inductance; but apart

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Tuning Circuits—Obvious and Otherwise—

from selecting valves for this characteristic there is nothing one can do to control the series

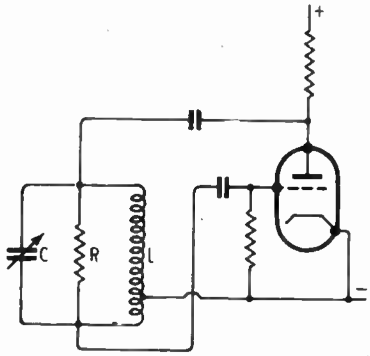


Fig. 5. A tuned transformer used to couple a valve back to its input gives the well-known Hartley oscillator circuit.

inductances directly. There is an indirect dodge, however—to insert external series capacitances having about equal reactance at the frequency concerned. These cancel out the inductance and enable one to "get at" the anode and grid.

In the original Fig. 2 types of circuit the valve capacitances are in parallel. It is possible by another dodge to reduce their effect and so raise the frequency; that is, by putting them in series. Supposing, for example, that the input and output capacitances are equal, then putting them in series instead of in parallel reduces their combined value to one quarter and (assuming there is no other tuning capacitance) doubles the frequency. The circuit then resolves itself into what I showed last month* to be a 1 : 1 transformer, as in Fig. 4. Here C_1 and C_2 are the output and input capacitances respectively of V1 and V2, and L_s consists of all the valve inductances, plus external series tuning inductance if any. When C_1 and C_2 are *not* equal, the transformer ratio (assuming R to be large compared with the reactances) is $C_2 : C_1$. Fortunately, C_1 is usually smaller than C_2, giving a step-down, though probably not the optimum step-down to match R. To vary the tuning, a series capacitor can be used to neutralize a variable amount of the inductance. And so we arrive at Fig. 1, which turns out to be a transformer-coupled circuit with (indirectly) variable inductance resonating with the two valve capacitances in series.

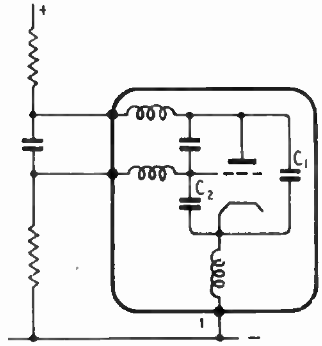


Fig. 7. A valve is a natural V.H.F. Colpitts circuit only needing anode to be connected to grid and supplies to be laid on.

An oscillator is simply an amplifier in which V1 and V2 are the same valve. So long as the amplification round the complete loop is not less than 1 at the frequency which causes anode and grid to be opposite in phase, oscillation of the system becomes possible.

One of the best sure-fire oscillators at all ordinary frequencies is the Hartley (Fig. 5). L is a transformer, and R is its dynamic resistance, taking into account any loading, losses, etc. The transformer ratio is set by the tapping point, which normally is near the grid end, because the anode-to-grid transformer step-down must cancel out the grid-to-anode voltage gain in the valve. If the tap is shifted toward the anode, the dynamic resistance of the circuit (looking from the anode) falls, and reduces the gain. This reduction is very likely to be more than counterbalanced, however, by the increase in oscillatory voltage at the grid caused by the change of ratio; so what happens then is that the oscillation grows in amplitude until it develops a negative bias sufficient to reduce the amplification to a level that restores the balance.

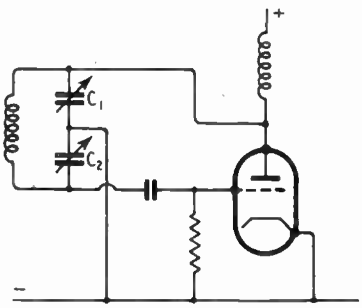


Fig. 6. If the transformer is tapped on the capacitance side we get the Colpitts circuit.

It is of course perfectly possible to provide C in the form of two capacitors in series. There is then the alternative of tapping the transformer on the C side instead of the L side, which alternative is named the Colpitts circuit (Fig. 6). Having just followed the argument from Fig. 2 to Fig. 4, you will no doubt see at once that there is a good reason for choosing the Colpitts for V.H.F., because nearly all the components are already in the valve, at no extra charge, as can be seen by drawing the interelectrode reactances (Fig. 7). A Colpitts circuit is created by the simple process of shorting anode to grid! For practical reasons it is of course necessary to do so through a blocking capacitor, and to supply anode and grid with appropriate voltages, but given these it is quite possible to make this oscillator, the ultimate in simplicity, work. It is analogous to Fig. 1 without the external inductance, except that anode-to-grid capacitance comes across the whole inductance and tends to lower the frequency, and the cathode is common to input and output, so its inductance comes out, tending to raise the frequency.

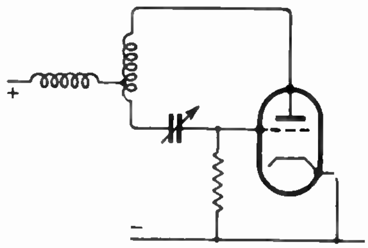


Fig. 8. This (which may be compared with Fig. 1) is often mistaken for a Hartley circuit; it is really a Colpitts.

* "Transformers—Obvious and Otherwise."

The frequency at which Fig. 7 oscillates lies, of course, in the lap of the valve-making gods. To render oneself less rigidly bound by them in the matter, the same device can be adopted as in Fig. 1—a variable capacitor for more or less neutralizing part of the inductance. A capacitor is needed anyway for blocking the anode supply voltage, so all that has to be done is to make it variable.

That is going to the valve's limit in high frequency, which approaches 400 Mc/s with a triode such as the EC52. For less extreme V.H.F., external inductance may be inserted in series between anode and grid. To avoid unnecessary loss due to the anode feed resistor or choke, it may be connected to the R.F. low-potential point that exists somewhere, usually between centre and grid end of the coil, instead of to the relatively high-potential anode end. The result, Fig. 8, then looks rather like a Hartley circuit, and is sometimes even called one. But in my view it is definitely not. The cathode or earth tapping point is not fixed by the feed tap, but in Colpitts fashion by the unshown valve capacitances. It is merely a loss-saving convenience that the anode feed is tapped to the point (as nearly as can be estimated), where it would work best in Hartley.

When one tunes Fig. 8 with so much shunt capacitance as to swamp the valve capacitances, the tapping point becomes less definitely established, and it is likely to be better to convert the circuit into a proper Hartley, say, by earthing the coil tap in Fig. 8 through a large capacitance. By that time we are back once more on familiar conventional moderate-frequency ground.

New Electronic Test Meter

THE Micovac test meter is basically a valve-voltmeter, but is of robust design and suitable for the ordinary needs of test and servicing work.

It provides for D.C. and A.C. voltage measurements up to 500 volts in five ranges, and with the addition of an external multiplier the D.C. facilities are extended to 5,000 volts. As the internal resistance is 1 MΩ per volt on D.C. up to 150 volts, and 50 MΩ total above 150 volts, direct measurement of A.G.C. bias voltages, screen potential and E.H.T. in television sets is possible. On A.C. the resistance is 10 MΩ total and the upper frequency

Micovac electronic test meter for D.C., A.C., R.F. and A.F. measurements. It can also be used as an ohmmeter for high resistances.

limit is 10 Mc/s up to 150 volts and 10 kc/s on the higher ranges. But by using an external probe unit the limit can be raised to 200 Mc/s.

The instrument also provides for D.C. and A.C. current measurements from 0-15 μA up to 0-1.5 A full-scale reading in five ranges and resistance up to 100 MΩ in two ranges.

It is self-contained and battery operated and is assembled in a functionally designed moulded case.

The makers are Electronic Instruments, Ltd., 17, Paradise Road, Richmond, Surrey, and the price is £24 10s. The 5,000-volt D.C. multiplier costs 22s and the V.H.F. probe unit 25s.

Manufacturers' Literature

LEAFLETS describing radio ceramics have been received from Steatite and Porcelain Products, Stourport-on-Severn, as follows: No. 2, Coil Formers and Inductors; No. 3, Stand-off and Aerial Insulators; No. 4, Metallized Bushes.

Catalogue of radio products and Technical Bulletin DTB1 giving data and recommended applications for "Maxi-Q" coils, from Denco (Clacton), 355-9, Old Road, Clacton-on-Sea.

Illustrated brochure (No. 220) dealing with Evershed position controllers, from Evershed and Vignoles, Acton Lane Works, London, W.4.

List of Government surplus components and equipment, from M. Watts, 38, Chapel Avenue, Addlestone, Surrey.

Pamphlet describing aerial installation service offered by Newhalk British Industries, 37, Brecknock Road, St. Pancras, London, N.7.

Unbiased

By FREE GRID

The Oldest Receiver

A READER has written to me to ask if I have an idea as to the age of the oldest wireless set in regular use. Of course, the key words are "regular use." I suppose that in such a case there is scarcely likely to be one older than that which he mentions as being known to him ; this set was built in December, 1925. But if we exclude the words "regular use" and substitute the phrase "occasional or emergency use," then the field becomes much wider, in which case a set of 1925 would be considered of very recent vintage, as I myself possess a crystal set made thirty-six years ago—in the year *Wireless World* was born.

This 1911 set still works as well as ever and was put to use last winter when Mr. Shinwell was suddenly compelled to shed the admittedly heavy load of my normal domestic wireless receivers, and it will be brought into use again this winter if his successor is forced to do the same thing.

I have little doubt that there are receivers in occasional use which are considerably older than this. If we include receivers which are kept as museum pieces, but are in working order, we can go back almost to the beginning of the century so far as those capable of receiving broadcasting are concerned. Among

Bellowing down the street.

such museum pieces are those using the Fleming diode (born 1904) and the magnetic detector (born 1902). The magnetic detector would certainly provide a generous amount of distortion, but no more than the set which I can hear bellowing down the street as I write. If we cut out broadcasting, i.e., telephony reception, we can go back to coherer sets a full half-century old which still exist. The earliest receiver was the simple Hertz ring or resonator of the late 'eighties, which, if a specimen exists at all, can scarcely fail to be in anything but working order and would still spark merrily if held near enough to a transmitter.

Chair of Scientific History Wanted

IN the course of a lifetime I have come across a large number of strange and out-of-the-ordinary people. Quite recently I met an outstanding-looking man of military appearance whom I judged to be a retired colonel. He was standing, almost purple with indignation, in front of a plaque erected on the sea front at Deal to mark the bimillenary of Julius Caesar's first landing there on August 25th, 55 B.C., right at the height of the holiday season. Although, as every schoolboy who has painfully construed his despatches knows, he quickly retired again until the following year, most probably because he was appalled at the August charges of the local landladies with their "coffee, two denarii extra."

At first I had some little difficulty in discovering the cause of the colonel's wrath, but at length he explained that he himself had been Julius Caesar in a previous existence and that not only did he land farther down the beach on the other side of the bandstand, but the date was open to criticism. To make his point clear, he led me through a maze of intricate and chronological calculations, including the translation of A.U.C. to B.C., in all of which, of course, he, as a reformer of the calendar, was an acknowledged expert.

I sympathized with him and pointed out that historians were notoriously inaccurate. I drew his attention to the fact that even the Jockey Club believed that James I initiated racing on Newmarket Heath, quite forgetting that as Queen Boadicea's H.Q. was only a couple of miles to the north of the heath it was scarcely likely that she would miss such a golden opportunity of indulging in her favourite sport of chariot racing, complete with wheel scythes.

It is, of course, a very regrettable fact that, even in scientific circles, historical accuracy is not always easy to come by, as the Editor obviously implied in the September issue (p. 338) when he said that some doubts had been thrown on his previous statement that Marconi's first great technical contribution to radio was the use of an aerial. The Editor made it quite clear, except to the most hardened pro-Popovian fanatics, that nothing yet said had caused him to retract, and that although Popov did use an aerial before Marconi he did not employ it for sending or receiving wireless messages or in any attempt to do so. Popov's sole idea was, as he himself stated, to "record

An outstanding-looking man.

electrical discharges in the atmosphere" or, in other words, to collect atmospherics.

Of course, the trouble is that some people regard atmospherics as wireless transmissions (as in one sense they are) just as they regard postwar sausages as food. I wish the Editor had gone a step further and given the *coup-de-grâce* to these doubting Thomases by pointing out that anybody who claims Popov as being the first to use an aerial really defeats his own argument. If Popov did forestall Marconi, then just as surely did Franklin with his kite forestall Popov, and if Popov's "recording of electrical discharges in the atmosphere" was wireless, then this definition applies equally to Franklin's sparks. Moreover, if this be admitted, we come to the *reductio ad absurdum* of having to admit that Franklin ante-dated Marconi's use for wireless reception of kite-borne aerials which, of course, he employed at Signal Hill, Newfoundland, in the experiments which culminated in the triumphant reception of Poldhu and the birth of transatlantic wireless on December 12th, 1901.

LETTERS TO THE EDITOR

Loudspeaker Damping: Aural Tests ♦ Combined Cinema-Television Entertainment ♦ Additive = Multiplicative?

Loudspeaker Damping

MAY I endorse the opinions of Mr. G. N. Patchett (your September issue) concerning aural tests made with amplifiers of low output resistance? The ear is, after all, the final judge, and I find that excessively low output resistance does not, at any rate to the ear, produce a proportionate improvement in transient response.

My amplifier is of push-pull construction throughout, using a high-quality pickup and triode-connected class A tetrodes in the output stage. The output impedance was varied between about 5 and 1 ohm by decreasing the effective "internal generator impedance" by using voice coil feedback overall (to the first stage) and varying the feedback factor. Transient response was carefully noted by listening tests with records containing drum and double-bass passages, particular attention being paid to the "hangover effect" and prolonged "boominess" which is so noticeable in some systems.

The performance of the amplifier without feedback is good (damping factor 2) and a very slight improvement was noticed up to a point when the latter was estimated to be 5. At this point transient "cut-off," particularly with drums, was very sharp and no further improvement by progressively increasing feedback could be noticed. I am, however, using two very good labyrinth loudspeakers where low-frequency resonances are taken care of by tuned air columns, so that any improvement in the bass resonant frequency due to good damping probably passes unnoticed to the ear.

A. E. CAWKELL.

Southall, Middx.

THE following experiment may be relevant to the loudspeaker damping discussion. If the speech coil of a moving-coil speaker is disconnected and the cone is tapped with the finger a short train of damped oscillations at a low frequency will be heard. When the speech coil is now short-circuited and the cone tapped again, no oscillation train is heard.

J. S. SMITH.

London, N.W.5.

Television—Cinema Merger?

THE recently imposed restrictions on the importation of American films are likely to revive the idea of bringing together the cinema and television as a source of entertainment.

On the technical side the problems are well on the way to solution; the greatest difficulties are likely to arise in reconciling conflicting commercial and other interests.

I suggest that the leaders of the television and cinema interests, with the co-operation of the B.B.C. and with backing from the Government, could launch cinema-television entertainment on a firm footing, greatly to our national advantage. A joint effort should be made: why not now?

JAMES N. ROE, G2VV.

Hampton-on-Thames.

F.M. and Dictatorship

I HAVE come out of a long sleep to realize that the opponents of wire broadcasting—among whom you, Sir, have been prominent—are prone to favour the introduction of frequency-modulation senders for distributing broadcast programmes.

The argument that wire broadcasting, in denying listeners the right and the means to pick up foreign stations, could be dangerous if a dictatorship were set up in this country seems to apply in equal measure to frequency-modulation systems.

What is the answer?

P. P. ECKERSLEY.

London, S.W.3.

"Magnetic Units": A Correction

I MUST apologize to you and to the rationalized m.k.s. system of units for obscuring its merits, and needlessly worrying readers by an unfortunate slip. In the example given on page 342, column 1, of your September issue the letter "I" persists where it should not. From the point at which it is supposed that "the current varies at the rate of 1 amp per second" to the end of that paragraph it should drop out. Self-inductance is therefore $\mu N^2 A/l$.

It should also be noted that "I" in Table 2, under the Symbol column, should read "Φ"; and the rationalized m.k.s. unit of H is the ampere-turn *per* metre.

It would have been well deserved if I had received impolite replies to my rhetorical question "What could be easier?" but readers seem to have been charitable.

"CATHODE RAY."

"*Television Aerials*"

MAY I correct an apparent misunderstanding in the comments by F. R. W. Strafford and J. N. Pateman in the September *Wireless World* on the article "Television Aerials," written jointly by myself and R. D. Beebe and published in your August issue?

The remarks on our method of band-width measurement indicate that the basis on which these measurements were made has not been fully appreciated. The curves and figures published were obtained by comparing, under identical conditions, the performance of various dipole and reflector arrays to that of a dipole alone, as explained in the text of the article. The various factors that Messrs. Strafford and Pateman suggest prejudice the accuracy of the results, affect each type of aerial equally, and obviously cancel out when comparisons are made. The band-width of the transmitting aerial constitutes one of these factors, and in early tests we did, in fact, retune this aerial at each frequency in order to eliminate its effect. The method, however, proved rather cumbersome, and was finally abandoned as it in no way altered the comparative results.

The theory of dipole aerials and reflectors has been well explored on the basis of various assumptions of perfection in material properties and position in space. Our investigation was concerned with the practical performance of these aerials under average installation conditions. To the best of our knowledge, balance-to-unbalance transformers are not used in commercial television installations owing to the negligible improvement obtained, and we therefore did not consider it advisable to use them in our tests. Their omission does not, of course, in any way affect the validity of our comparative results.

Our general conclusion that a particular ⅛th-wave spaced array has certain advantages over a normal ¼-wave spaced array for television reception was not based solely on the fact that the former has a better front-to-back ratio on the sound frequency. We would point out that there is no corresponding drop in this ratio on the vision band, and, in addition, the more even band-width response and improved mechanical construction led to our decision that the balance of advantage was definitely in favour of the ⅛th-wave spaced array.

N. M. BEST.

Antiference, Ltd., London, W.1.

"Ignition Interference"

The concluding Part of this article is unavoidably held over

"*Heterodyning and Modulation*"

DO additive and multiplicative mixing amount to the same thing? To answer that, consider another question: Do adding £400 to an M.P.'s 1944 salary, and multiplying it by 5/3, amount to the same thing? So far as the M.P. is concerned, presumably they do. But is it fair to infer from this that there is no difference between addition and multiplication? If the 1944 level had been £200 instead of £600 the difference would have been marked. It is true that basically multiplication is repeated addition, but this concept has been so extended in our modern use of multiplication that for practical purposes they are treated—surely quite rightly?—as being entirely distinct operations.

Mr. Mitchell's comparison between heterodyning and modulation brings out a number of interesting points, and no one could reasonably deny that there is a close relationship between the two processes—just as there is between the two arithmetical operations. But his argument that therefore it is a mere outworn convention to see a distinct difference between the two methods of "mixing" is, I suggest, regrettable, for the following reason. One of the common confusions of students is to suppose that mere addition of two wave-trains is enough to produce a beat frequency; it is desirable therefore to emphasize the difference from multiplicative mixing, rather than the similarity.

Mr. Mitchell's comparison between suppressor-grid modulation and Class C control-grid modulation can only confuse rather than clarify the issue, because he uses a term—"effective gain"—which is neither defined nor self-explanatory. Assuming "ideal" valve characteristics, and describing the process in clearly defined terms, the comparison actually emphasizes the distinction between them.

Lest it should be supposed that any such distinction is purely theoretical, it may be well to remember that in the design of frequency changers it has a practical significance. Other things being equal, the multiplicative method has the advantages of a higher conversion conductance (the limiting ratio is $2:\pi$) and the output components of undesired frequency are less.

M. G. SCROGGIE.

Bromley, Kent.

Short-wave Conditions

Expectations for November

By T. W. BENNINGTON (Engineering Division, B.B.C.)

DURING September the average maximum usable frequencies for these latitudes increased somewhat during the daytime, and decreased considerably during the night. This was in accordance with the normal seasonal trend, though the daytime increase was less than would have been expected, probably owing to the fact that there was a lot of ionosphere storminess.

Daytime working frequencies were, therefore, not so high as had been anticipated, though on a few undisturbed days particularly high frequencies might have been used. Night-time working frequencies were such that 11 Mc/s was about the lowest frequency really necessary for most paths. Sporadic E was much more prevalent than is usual during September, and medium-distance communication on high frequencies was often possible by way of this medium.

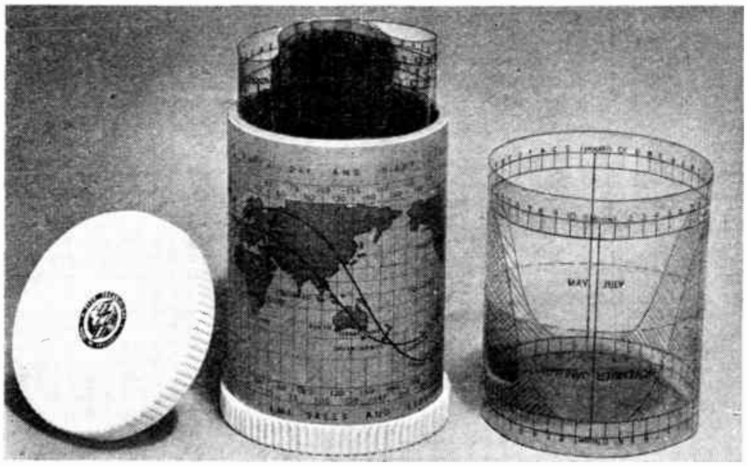
Conditions were very disturbed during the month, the worst periods of ionosphere storminess being 3rd/4th, 7th/8th, 12th/22nd and 24th/26th. The worst conditions of all prevailed on 18th and 25th, on both of which nights the Aurora Borealis was reported as being visible in this country.

Forecast.—Daytime M.U.F.s during November should be even higher than during October over many paths, and should, it is expected, be the highest to be reached during the present sunspot cycle. Long-distance communication on exceptionally high frequencies will be frequently possible in all directions from this country. The 28-Mc/s amateur band, for example, should be *regularly* usable over daylit paths, and should frequently remain usable in west and south-west directions till about 2000 G.M.T. on undisturbed days. Conditions will be at their best for the establishment of long-distance contacts on 50 Mc/s, though, of course, it is by no means certain that the ionization will reach values high enough to sustain such propagation. Night-time M.U.F.s will, on the other hand, be considerably lower than during October. On some circuits frequencies as low as 9 Mc/s will be necessary in order to maintain regular night-time communication, and, in a few directions, frequencies even lower than this may have to be used.

Below are given, in terms of the broadcast bands, the working frequencies which should be regularly usable during November for four long-distance circuits running in different directions from this country. All times here are in G.M.T. In addition, a figure in brackets is given for the use of those whose primary interest is the exploitation of certain frequency bands, and this indicates the highest frequency likely to be usable for about 25 per cent of the time during the month for communication by way of the regular layers :—

Montreal :	0000	9 Mc/s		(15 Mc/s)
	0700	7 ,,		(13 ,,)
	0900	11 ,,	or 15 Mc/s	(17 ,,)
	1100	21 ,,		(28 ,,)
	1200	26 ,,		(40 ,,)
	1900	21 ,,		(36 ,,)
	2000	17 ,,	or 15 Mc/s	(25 ,,)
	2200	11 ,,		(18 ,,)
Buenos Aires :	0000	11 Mc/s		(17 Mc/s)
	0400	9 ,,		(15 ,,)
	0600	11 ,,		(19 ,,)
	0800	21 ,,		(28 ,,)
	0900	26 ,,		(41 ,,)
	1900	21 ,,		(32 ,,)
	2000	17 ,,	or 15 Mc/s	(25 ,,)
	2300	11 ,,		(19 ,,)
Cape Town :	0000	11 Mc/s		(16 Mc/s)
	0500	17 ,,		(24 ,,)
	0600	21 ,,		(30 ,,)
	0700	26 ,,		(42 ,,)
	1800	21 ,,		(32 ,,)
	1900	17 ,,		(26 ,,)
	2100	15 ,,		(22 ,,)
	2300	11 ,,		(18 ,,)
Chungking :	0000	9 Mc/s		(15 Mc/s)
	0400	11 ,,	or 15 Mc/s	(20 ,,)
	0600	21 ,,		(28 ,,)
	0700	26 ,,		(38 ,,)
	1200	21 ,,	or 17 Mc/s	(30 ,,)
	1500	15 ,,		(22 ,,)
	1800	11 ,,		(18 ,,)
	2000	9 ,,		(15 ,,)

Though ionosphere storms are not particularly prevalent during November, those which do occur are likely to be rather troublesome during the dark hours. At the time of writing it would appear that such disturbances are more likely to occur within the periods 1st/2nd, 8th/9th, 11th/13th, 17th/19th, 24th/25th and 28th/29th, than on the other days of the month.



DAY OR NIGHT ? This device, the Fisk Solariscope, shows the prevailing conditions of daylight or darkness over a given signal path by superposing a transparent shadow chart on the cylindrical map body. Designed by Sir Ernest Fisk, it is produced by E.M.I. Sales and Service.

RANDOM RADIATIONS

By "DIALLIST"

The Show

DESPITE all those exhibitionless years, the man in the wireless street has certainly not lost the habit of visiting Radiolympia! One expected crowds, but I doubt whether the most optimistic of the show's organizers had dared to hope for anything like the numbers that turned up. When the attendance on the opening day set up what the Americans call an "all-time high" (though we save time by contenting ourselves with the two syllables of "record"!) by nearly doubling the previous best figures it was evident that there had been no waning of popular interest in wireless and television. On the preview day an old hand asked me: "What do you think's the most outstanding thing here?" I suppose that he expected me to reply by naming some particular apparatus; but my answer was: "The fact that, with all our shortages of materials, fuel and man-power, it's been possible to put on a show with such a high general standard." That, I still think, was the most striking feature of Radiolympia. There was little, when you come to reflect on it, in the way of startling novelties, but there were any amount of radio receivers, televisors and components showing the good design and the good workmanship which are the things that really matter. I'd had to apologize to two distinguished foreign visitors for the dull and rather meagre bill of fare at lunch; but I certainly did not have to make any apologies when we got to Olympia!

□ □ □

Puzzling

ONE of the most surprising conclusions arrived at by the Central Price Regulation Committee in their deliberations on our valve prices was that American broadcast receiving sets differed from ours in containing a comparatively large number of valves of but moderate efficiency. That may have been true twelve or fifteen years ago, but it certainly isn't to-day. The most popular type of broadcast receiving set in the U.S.A. nowadays has four "working" valves and a rectifier. And the arrangement is very much what you would expect to find if you looked inside the cabinet of one of our sets: triode-hexode, variable-gain I.F., D.D.T., pentode output and D.D. mains rectifier. What has long been a puzzle to me is this: if you spend it on accommodation or food or other necessities of life the dollar goes nowhere in the United States. But an average price for a 4V+ receiving set is $28-$29.50, or say seven pounds to seven guineas. Receiving valves there are half the price of ours. Similarly a 60-watt bulb of first-rate make costs 6½d and a 40-watt fluorescent tube about 2s. Some other things though are dearer proportionately in the U.S. than they are here. It's a queer world if when money talks it speaks a variety of languages!

□ □ □

A Useful Book

FROM its author, Monsieur L. Gaudillat, I received recently a copy of the useful little "Dictionnaire Radiotechnique (anglais-français)" published in Paris by the Société des Editions Radio. The book is not confined, as its title might suggest, to radio alone; it contains actually the French equivalents of the great majority of the technical terms used in both English and American publications dealing with electronics and with general electricity. I can't claim to have made an exact count of the number of references; but totting up those on a page opened at random and multiplying by the number of pages gives the respectable total of 5,390. In addition the *dictionnaire* has handy conversion tables for English and metric units of measurements of all kinds, including fractions of an inch to millimetres from one sixty-fourth to one inch, and the metric equivalents of various wire gauges from No. 00000 to No. 45. Even though it is a one-way dictionary only and that one way is English-French, the book should be a help to any one who has to read French technical books or periodicals. It enables you to see, for example, whether your proposed translation of a French term is right or not. If it's wrong, intelligent use of the book should make it a simple matter to find the right answer.

□ □ □

Switches and Shocks

A KIND correspondent reminds me, with reference to my remarks last month about the desirability of using double-pole mains switches in wireless sets, that there is an I.E.E. regulation reading: "A reversible connector shall not be used to connect an electrical appliance to the supply unless every switch on the appliance is of the double-pole type." Yes, I did know that; but most unfortunately the I.E.E. Regulations have not the force of law. They are, as matters stand, just carefully drawn-up recommendations. Some day soon, one hopes, they will have the backing of the law behind them. When that happens there will be a big drop in the number of accidents due to electricity. In the U.S.A., I believe, insurance companies have done good work by making the use of approved types of apparatus and wiring systems a condition of their accepting normal premium rates.

□ □ □

'Ware This One!

It's not always an easy business to check over the wiring of a new house when you move into one and there's a particular booby trap which it is always worth while to bear in mind. Having made such a move, a friend was not satisfied with the 5-amp two-pin socket which, from its position, had clearly been used by the previous owner for running his wireless receiver. He decided to substitute a three-pin socket. The house contained 15-amp and 5-amp circuits, with separate meters and master switches. Having switched off the 5-amp circuit, he got to work on the socket and promptly received a most unpleasant shock when he applied a screw-driver to its "live" terminal. The lifting of a floorboard bearing the tell-tale marks of an "electrician's chisel" disclosed that this socket was neatly tapped into the 15-amp circuit. This sort of thing is not uncommon in houses provided with separate power and lighting meters. The idea is, of course, to save money on the electricity bill by running the set on current supplied at the cheaper rate. Apart from that, I wouldn't put it past electricians of the baser sort to do the same kind of thing when called in to install a lighting socket.

□ □ □

Surplus

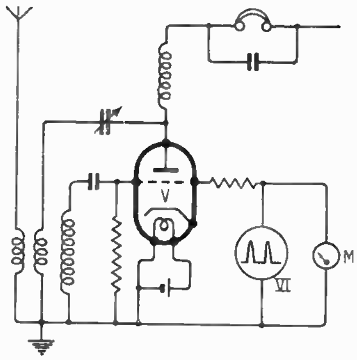
IT'S very interesting to spend an hour or two in exploring the contents of the shops which make a feature of war surplus radio gear. There's a good deal of useful stuff to be picked up if you buy carefully; but there is also no small amount of elaborate apparatus, which, though it may be beautifully made and must originally have cost a tidy packet, is now of little practical use to the wireless man. There is always the temptation to buy this or that just because its present price is a mere fraction of what it cost to make. By spending a few pounds without much thought one might easily acquire a barrow load of gear of attractive appearance, for which it would eventually prove difficult to discover practical uses. Too often conversion which at first sight appears so simple turns out, when you come to tackle the job, to be an involved and expensive business. From our point of view the trouble with a great part of the war surplus radio material is that it was made for highly specialized purposes which don't fit in with our normal requirements. There are naturally lots of things—meters, for example, of various kinds—which are exactly what we long to possess, but as many others are filled with similar yearnings you don't often find the good ones offered at give-away prices.

RECENT INVENTIONS

A Selection of the More Interesting Radio Developments

SUPER-REGENERATORS

A SUPER-REGENERATIVE circuit is used both as a transmitter and a receiver for short-range radar. The quenching frequency of the valve is manually adjusted until it coincides with the time interval between an outgoing pulse and the incoming echo from a distant reflector. Coincidence occurs when the normal "hiss" ceases in the valve output, the quench-frequency control being calibrated to show the range of the body then under observation.



Super-regenerative circuit for radar.

As shown, the valve V is periodically quenched by short pulses applied to its grid from an oscillator V_1. The repetition-frequency of the latter is adjusted by a calibrated control M until no output is heard in the headphones. This shows that the echoes are returning precisely when the quench is removed, because only then can they dominate the "noise-level" normally present in the input circuit.

The control can be pre-set to give an automatic warning of the approach of any reflecting body within a given distance of the set.

A. C. Cossor, Ltd., and F. R. W. Strafford. Application date December 30th, 1942. No. 581982.

DIRECTIVE AERIALS

TWO wave guides are joined to form a vee-shaped unit, which is energized, at the junction, by two probes diverging from a common coaxial line. The two walls that face each other, along the vee, are slotted so that energy is progressively fed into the open space between the guides. Since the phase velocity of the energy inside the guides differs from that of the wave in free space, various directional effects can be obtained by controlling the phase relation between them.

For instance, the dimensions of the guides or the angle between them can be varied; or the phasing along the length of each guide can be adjusted by the use of an end reflector; or the size of the slots in the two opposing faces can be graded to control the rate at which energy is radiated from them. The cross-section of the beam can thus be controlled and subsidiary lobes eliminated.

The Board of Trustees of the Leland Stanford Junior University. Convention date (U.S.A.) July 10th, 1940. No. 581762.

The British abstracts published here are prepared with the permission of the Controller of H.M. Stationery Office, from specifications obtainable at the Patent Office, 25, Southampton Buildings, London, W.C.2, price 1/- each.

DIRECTION FINDING

IN a rotating system with two diverging aerials, the direction of the signal that gives equal strength on both aerials must be along the line bisecting the angle between them. This can conveniently be indicated on a cathode ray tube by presenting the signal against a circular time base which is synchronized with the rotation of the aerial system. Simultaneously the distance of the reflecting body or target can be indicated as a radial deflection against a linear time-base, which is synchronized with each exploring pulse.

According to the invention, the signals received on each of the diverging aerials are separately rectified, and are then applied differentially to the control grid of the C.R. tube, in such a way that an initial black-out bias is not removed, and the indicating spot is not rendered visible, until the line bisecting the angle between the aerials passes through the source of the echo signal. The arrangement thus gives a positive indication, and avoids the ambiguity of certain other systems where a null reading may be given in the absence of any signal.

C. S. Agate and A. H. Cooper. Application date, September 25th, 1941. No. 581806.

TELEVISION

THE idle or flyback periods between the scanning lines are utilized for the transmission of sound signals, so that only one carrier wave is required for the complete television service. At the same time, no storage or delay device is needed for the proper presentation of the two sets of signals.

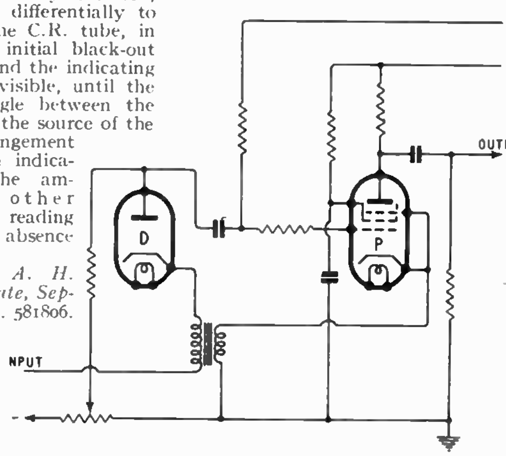
The audio signals are first converted into a train of pulses, which have the same repetition frequency as that used for scanning, but which are modulated in width in accordance with the sound. They are then synchronized to coincide with the flyback periods of the scanning system. In reception, the video and audio signals are separated by passing them through a valve in which a cut-off bias is periodically removed by multivibrator pulses timed to prevail only during the idle periods between successive scanning lines.

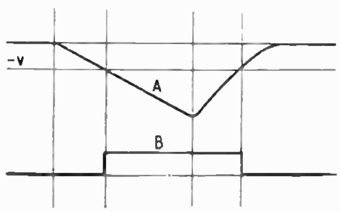
Marconi's Wireless Telegraph Co., Ltd. (assignees of G. L. Fredendall). No. 586034.

PULSE GENERATORS

THE circuit shown is designed to generate a square-shaped pulse at a predetermined time after the application of a saw-toothed voltage A.

In the quiescent state of the pentode P, the control grid is taking current, and the anode voltage is at minimum. A negative bias —V is applied from a potentiometer tapping to the anode of a diode D in the grid circuit. As the saw-toothed input A passes through the critical —V voltage, the diode becomes conductive and transfers the input direct to the grid, causing the anode





Square pulse generator with saw-toothed imput.

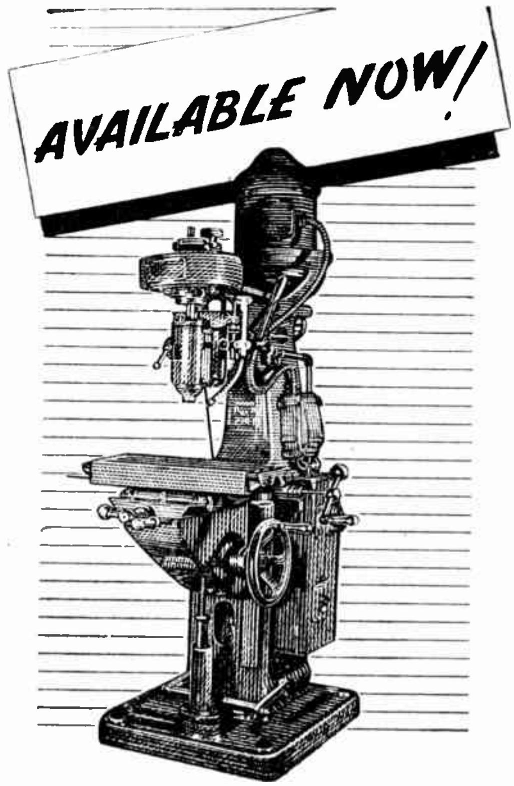
voltage to rise sharply, as shown in the curve B. The resulting drop in the cathode current applies a regenerative kick to the grid across the transformer T. This accentuates the trigger effect and sharpens the leading edge of the pulse delivered by the anode.

F. C. Williams. Application date, October 2nd, 1944. No. 583553.

MAGNETOSTRICTION TRANSDUCERS,
care and feeding of

If we were talking nonsense we should say take lots of amps and volts and what have you, cram them all down the throat of any old Transformer you happen to have lying around, then stand back and try to smile while it slowly wrecks all your equipment.
On the other hand if we're talking very "B.Sc." we'd say that the above unpronounceable words are Transformers used for converting electrical into ultrasonic sound or power (or v.v.) for underwater signalling apparatus.
On the other hand if man to man we're talking sheer, sound, rock bottom common sense then we do not try to explain at all - we just tell you that Parmeko of Leicester make darn good Transformers for the Electronic and Engineering Industries - this is good friendly advice and could save you a lot of bother . . . if you contact us.

PARMEKO OF LEICESTER.
MAKERS OF TRANSFORMERS.



machine tools

OF NUMEROUS TYPES

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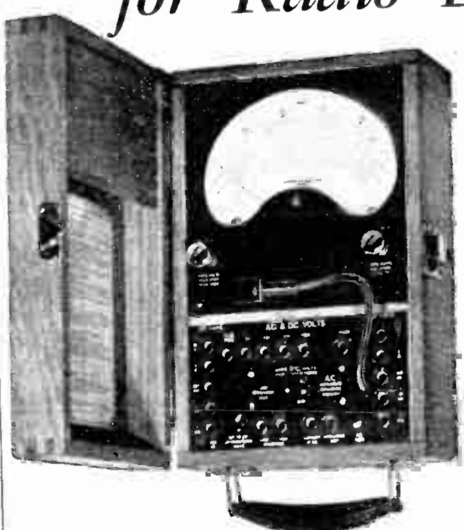

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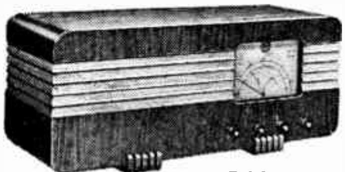

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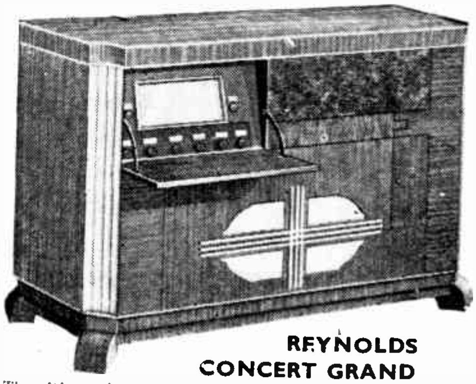

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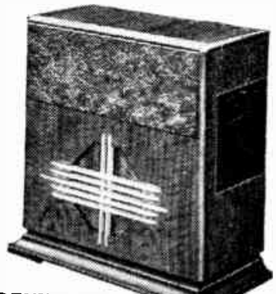

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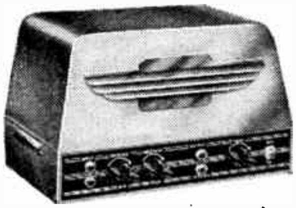

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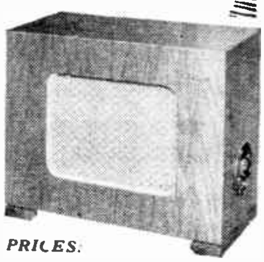

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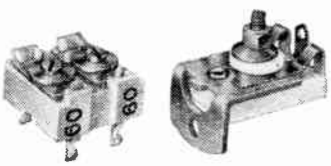

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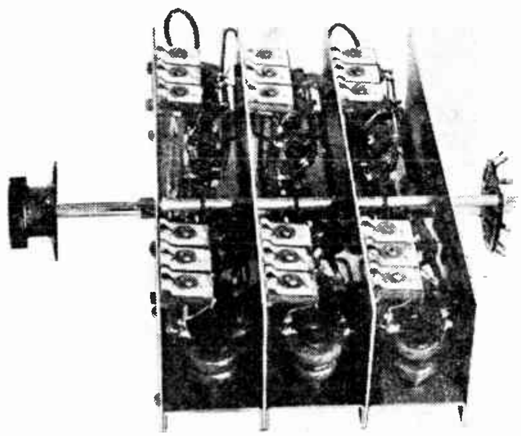

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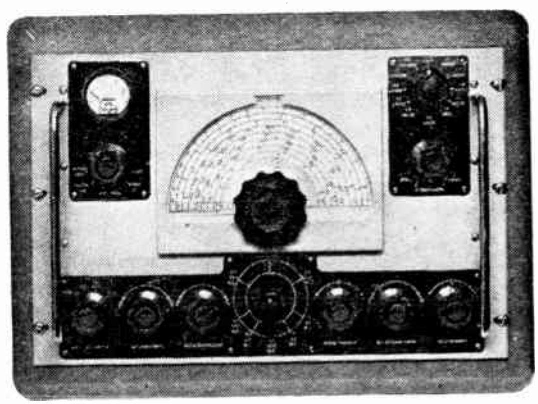

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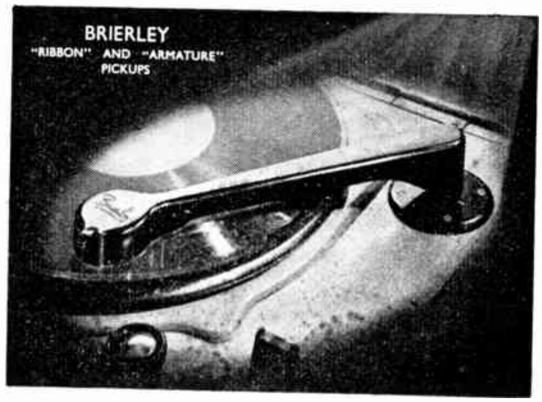

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MURPHY TA92 comm. receiver, 10-550m, 4 months old; list price, maker's guarantee; Columbia 5v radiogram, 2 waveband, A.C., perfect condition; nearest £50, fetched. —Jackson, 9, Chester Rd., Newquay. [8616

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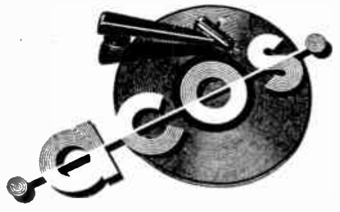

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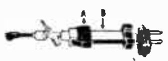

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R1155 receiver with loudspeaker, power pack in steel case and built-in power stage, £23; television set, newly built, 10in×8in picture, £85.—Write Day, 36, Vivian Ave., Wembley. [8437

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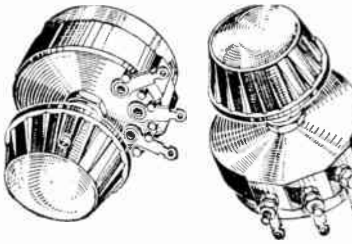

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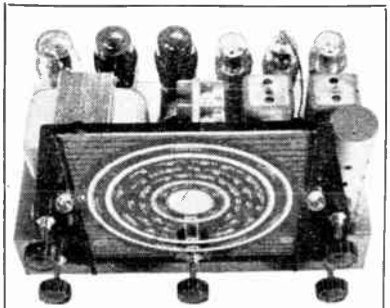

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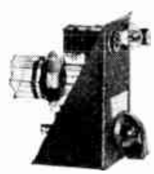

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CHIEF of progress required by large radio concern in West London area, 30-35 years of age, experience of factory progress routine in all departments essential, including assembly, shops, coil room and press shop, etc.—Full details, salary required etc., to Box 3443.

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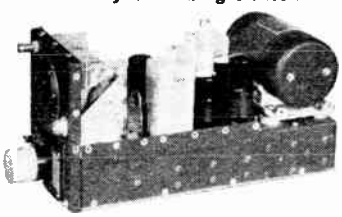

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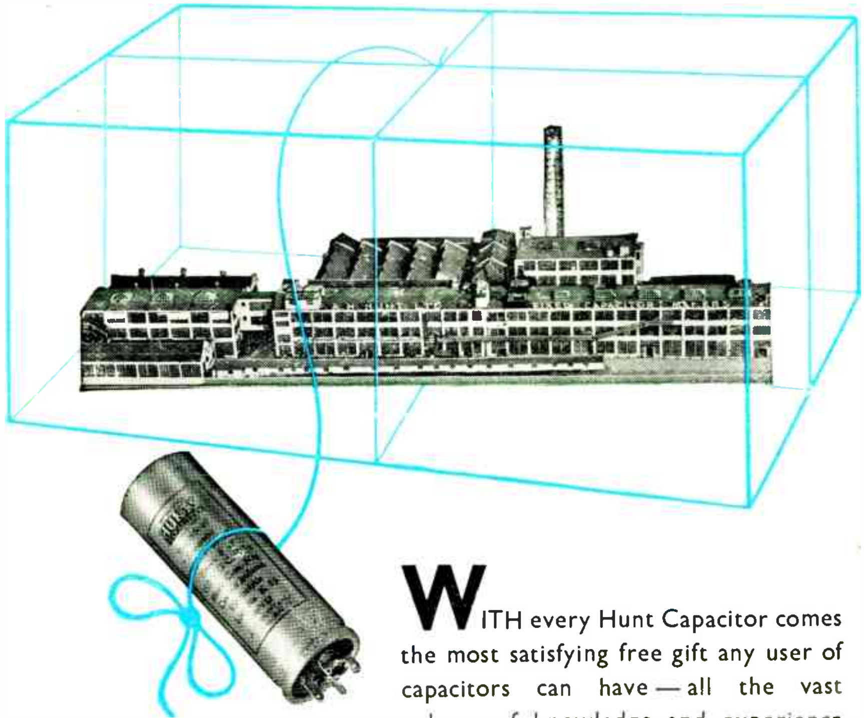

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A section of the conveyor on the Ersin Multicore Stand where a complete Bush coil unit was manufactured every five minutes.

FOR those who were unable to visit Radiolympia, we show sections of the Ersin Multicore Solder exhibit, with a view to illustrating the way in which Ersin Multicore Solder wire is used in the production of radio components and receivers.

Operatives from radio factories in the London area showed visitors to Radiolympia how they make soldered joints on radio equipment using Ersin Multicore Solder wire.

This was the largest working exhibit ever shown by an individual exhibitor at Radiolympia and was virtually a model radio factory. Eight girls from the Bush Radio Works, Chiswick, are shown seated at benches adjacent to a flowline conveyor. Every 5 minutes the 200 parts of a coil unit were gradually assembled and by the time they had finished their journey on the conveyor, 70 Multicore soldered joints were made and a complete coil unit manufactured. By the closing day 550 coil units were manufactured from 1,110,000 parts involving 38,500 Multicore soldered joints.

Soldering operations on capacitors, at the rate of 500 and 1,000 joints per hour, were made on another section of the Multicore Stand by girls from A. H. Hunt's capacitor factory. 8,000 pieces per hour of Ersin Multicore Solder were cut by an ingenious machine devised by this firm, and 181,500 Multicore soldered joints were made on capacitors by the closing day.

Other exhibits on the Multicore Solders stand included equipment from the Company's Research Laboratories. These comprised a specially designed hot plate used for testing the spread and flow of fluxes and alloys.

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Each contains 3 ft. of Ersin Multicore Solder 40/60 alloy 16 S.W.G. Sufficient for 200 average joints. Retail 6d.

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C 14013	13	27 ft.	4 10
C 14016	16	60 ft.	5 3

The Hunt's girls who made 500 to 1,000 joints an hour with Ersin Multicore Solder.

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